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Dr. Wm. J. Taylor.

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TRANSACTIONS

OF THE

AMERICAN

SURGICAL ASSOCIATION

VOLUME THE TWENTY-NINTH

EDITED BY

ARCHIBALD MACLAREN, M.D.,
RECORDER OF THE ASSOCIATION

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OFFICERS OF THE ASSOCIATION,

ELECTED JUNE, 1911.

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ARPAD G. GERSTER, M.D.

VICE-PRESIDENTS.

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GEORGE W. CRILE, M.D.

SECRETARY.

ROBERT G. LE CONTE, M.D.,
1530 Locust St., Philadelphia.

TREASURER.

CHARLES A. POWERS, M.D.,
Fourteenth and Stout Sts., Denver, Col.

RECORDER.

ARCHIBALD MAC LAREN, M.D.,
303 Lowry Annex, St. Paul, Minn.

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ROBERT G. LE CONTE, M.D.,
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ARCHIBALD MAC LAREN, M.D.,
} *Ex-officio.*

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RECORDER, SECRETARY, AND TREASURER, *ex-officio*.

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FREDERICK B. LUND, M.D., HOWARD LILIENTHAL, M.D., PRESIDENT, SECRETARY, RECORDER, AND THE CHAIRMAN OF THE ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS, *ex-officio*.

COMMITTEE ON NECROLOGY, CREATED IN 1884.

(Report by Title.)

F. H. GERRISH, M.D.,
N. B. CARSON, M.D.,
WM. L. RODMAN, M.D.

Place of next meeting:

MONTREAL, CANADA, MAY 29, 30, 31, 1912.

ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS.

GEORGE E. ARMSTRONG, M.D., *Chairman*,
FRANCIS J. SHEPHERD, M.D.,
ALEXANDER PRIMROSE, M.D.

DELEGATES TO THE CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS, WASHINGTON, D. C., 1913.

WILLIAM H. CARMALT, M.D., *Delegate*,
GEORGE BEN JOHNSTON, M.D., *Alternate*.

LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION.

ELECTED

1880. †SAMUEL DAVID GROSS, M.D., LL.D., D.C.L. Oxon., LL.D. Cantab., LL.D. Edin.—Founder of the Association.
1883. †EDWARD MOTT MOORE, M.D., LL.D.
1884. †WILLIAM THOMPSON BRIGGS, M.D.
1885. †MOSES GUNN, A.M., M.D., LL.D.
1886. †HUNTER McGUIRE, M.D., LL.D.
1887. †D. HAYES AGNEW, M.D., LL.D.
1888. DAVID WILLIAMS CHEEVER, M.D., LL.D.
1889. †DAVID W. YANDELL, M.D.
1890. †CLAUDIUS HENRY MASTIN, M.D., LL.D.
1891. †PHINEAS SANBORN CONNER, M.D., LL.D.
1892. †NICHOLAS SENN, M.D., Ph.D., LL.D.
1893. JAMES EWING MEARS, A.M., M.D., LL.D.
1894. FREDERIC SHEPARD DENNIS, M.D.
1895. LOUIS McLANE TIFFANY, A.M. Cantab., M.D.
1896. JOHN COLLINS WARREN, M.D., LL.D. (Jefferson), Hon. F.R.C.S. Eng.
1897. †THEODORE F. PREWITT, M.D.
1898. WILLIAM W. KEEN, A.M., M.D., LL.D., Hon. F.R.C.S. Eng.
1899. ROBERT F. WEIR, A.M., M.D., F.R.C.S. Eng.
1900. ROSWELL PARK, M.D.
1901. †DE FOREST WILLARD, A.M., M.D., Ph.D.
1902. MAURICE H. RICHARDSON, A.B., M.D.
1903. †NATHANIEL P. DANDRIDGE, M.D.
1904. GEORGE BEN JOHNSTON, M.D.
1905. ALBERT VANDER VEER, M.D.
1906. DUDLEY P. ALLEN, M.D., LL.D.
1907. WILLIAM H. CARMALT, M.D.
1908. C. B. G. de NANCRÈDE, A.M., M.D., LL.D.
1909. RUDOLPH MATAS, M.D.
1910. RICHARD H. HARTE, M.D.
1911. ARPAD G. GERSTER, M.D., Chir.D.

† Deceased.

NOTICE

This volume of TRANSACTIONS contains the papers read before the Association at the Meeting held June 19, 20 and 21, 1911.

The Association assumes no responsibility for the statements and opinions published in this volume.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION

JUNE, 1911

* Denotes Original Fellows.
† Denotes Senior Fellows.

ELECTED

1890. ABBE, ROBERT, M.D., 13 West Fiftieth Street, New York, Surgeon to St. Luke's Hospital. *Vice-President*, 1901.

1894. ALLEN, DUDLEY P., A.M., M.D., LL.D., 8811 Euclid Avenue, Cleveland, Ohio. Professor Emeritus, Medical Department of Western Reserve University. *President*, 1906; *Member of Council*, 1908.

†1890. ALLIS, OSCAR HUNTINGTON, A.M., M.D., 1604 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital.

1902. ANDREWS, E. WYLLYS, A.M., M.D., 2525 Prairie Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Surgeon to Mercy Hospital and Michael Reese Hospital; Attending Surgeon to Cook County Hospital; Consulting Surgeon to the Provident Hospital.

1901. ARMSTRONG, GEORGE E., C.M., M.D., 320 Mountain Street, Montreal. Professor of Surgery and of Clinical Surgery McGill University; Surgeon to the Montreal General Hospital; Surgeon to the Western Hospital, Montreal.

1906. BARROW, DAVID, M.D., 148 Market Street, Lexington, Ky.

†1882. BARTON, JAMES M., A.M., M.D., 32 North New Hampshire Ave., Atlantic City, N. J.

1900. BEVAN, ARTHUR DEAN, M.D., 122 S. Michigan Boulevard, Chicago. Professor and Head of the Department of Surgery,

ELECTED

Rush Medical College, University of Chicago; Surgeon to Presbyterian Hospital.

1901. BINNIE, J. F., M.B., C.M. (Aberdeen), Argyle Bldg., Twelfth and McGee Sts., Kansas City, Mo. Professor of Surgical Pathology and Clinical Surgery, Kansas City Medical College. *Vice-President*, 1907.

1906. BLAKE, JOHN BAPST, A.M., M.D., 178 Beacon Street, Boston, Mass. Instructor in Surgery, Harvard Medical School; Assistant Surgeon to the Boston City Hospital; Surgeon to the Long Island Hospital and St. Elizabeth's Hospital, Boston, Mass.

1902. BLAKE, JOSEPH A., M.D., 601 Madison Avenue, New York. Instructor in Surgery, Columbia University; Attending Surgeon to St. Luke's Hospital; Junior Surgeon to the Roosevelt Hospital; Consulting Surgeon to the Northern Dispensary.

1901. BLOODGOOD, JOSEPH C., B.S., M.D., 904 North Charles Street, Baltimore, Md. Associate in Surgery in the Johns Hopkins University.

1901. BOSHER, LEWIS C., M.D., 422 East Franklin Street, Richmond, Va. Professor of Practice of Surgery, Medical College of Virginia; Visiting Surgeon, Memorial Hospital.

†1890. BRADFORD, EDWARD HICKLING, A.B., M.D., 133 Newbury Street, Boston. Surgeon to the Children's and the Samaritan Hospitals; Assistant Professor of Orthopedic Surgery, Harvard University.

1900. BREWER, GEORGE EMERSON, M.D., 61 West Forty-eighth Street, New York City. Professor of Clinical Surgery in College of Physicians and Surgeons, Columbia University; Junior Surgeon, Roosevelt Hospital; Attending Surgeon, City Hospital; Consulting Surgeon to the Ophthalmic and Aural Institute, and to the Perth Amboy Hospital.

1906. BRISTOW, A. T., A.B., M.D., 234 Clinton Street, Brooklyn, New York. Clinical Professor of Surgery at the Long Island College Hospital; Attending Surgeon to the Kings County Hospital, St. John's Hospital, and Long Island College Hospital; Consulting Surgeon to the Long Island State Hospital, the Bushwick Central Hospital, and the Swedish Hospital.

1911. BRUCE, HERBERT A., M.D. (Toronto Univ.), L.R.C.P. London, F.R.C.S. England, 64 Bloor Street East, Toronto, Canada. Associate Professor of Clinical Surgery, University of Toronto; Surgeon to the Toronto General Hospital.

1895. BRYANT, JOSEPH D., M.D., 32 West Forty-eighth Street, New York. Professor of Anatomy and of Operative and Clinical

ELECTED

Surgery, Bellevue and St. Vincent's Hospitals; Consulting Surgeon to Gouverneur Hospital, Hospital for Ruptured and Crippled, St. Joseph's and Hackensack Hospitals, Asylum for Insane, New York, etc.

1911. BUCHANAN, J. J., A.M., M.D., PH.D., 1409 N. Highland Ave., Pittsburg, Pa. Professor of Surgery, University of Pittsburg; Surgeon to Mercy Hospital and to Columbia Hospital.

1900. BUNTS, FRANK E., M.D., 1021 Prospect Street, Cleveland, Ohio. Professor of Principles of Surgery and Clinical Surgery in Medical College of Western Reserve University; Visiting Surgeon to St. Vincent's Charity Hospital; Consulting Surgeon to Cleveland City and Lutheran Hospitals.

1889. CABOT, ARTHUR TRACY, A.M., M.D., 1 Marlborough Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

†1885. CARMALT, WILLIAM H., A.M., M.D., 87 Elm Street, New Haven, Conn. Professor of Surgery in Yale University; Surgeon to the New Haven Hospital. *President*, 1907; *Vice-President*, 1895; *Member of Council*, 1908.

1909. CARREL, ALEXIS, L.B., SC.B., M.D., Rockefeller Institute for Medical Research, Sixty-sixth Street and Avenue A, New York, N. Y.

1896. CARSON, NORMAN BRUCE, M.D., 303 Humboldt Bldg., St. Louis, Mo. Professor of Clinical Surgery in the St. Louis Medical College; Surgeon to St. Louis and Mullanphy Hospitals and to the St. Vincent Insane Asylum, etc. *Vice-President*, 1903.

†1882. CHEEVER, DAVID WILLIAMS, M.D., LL.D., 557 Boylston Street, Boston, Mass. Professor of Surgery (Emeritus) in Harvard University; Surgeon to Boston City Hospital. *President*, 1888.

1896. COLE, CHARLES KNOX, A.M., M.D., Helena, Montana. Surgeon to St. John's, St. Peter's, and County Hospitals.

1898. COLEY, WILLIAM B., M.D., 40 East Forty-first Street, New York. Attending Surgeon to the General Memorial Hospital; Associate Surgeon to the Hospital for Ruptured and Crippled, New York.

1905. CRILE, GEORGE W., M.D., *Vice-Pesident*, 1021 Prospect Street, Cleveland, Ohio. Professor of Clinical Surgery, Western Reserve Medical College; Visiting Surgeon to St. Alexis' Hospital; Associate Surgeon to Lakeside Hospital.

1906. CUSHING, HARVEY, A.M., M.D., 107 East Chase Street, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

ELECTED

1896. Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass. Junior Visiting Surgeon, Boston City Hospital; Assistant Surgeon, Children's Hospital, Boston.

1897. Da Costa, John Chalmers, M.D., 2045 Walnut Street, Philadelphia, Pa. Professor of Surgery, Jefferson Medical College: Surgeon to the Philadelphia and the Phœnixville Hospitals.

1909. Davis, Gwilym G., M.D., M.R.C.S. Eng., 1814 Spruce Street. Philadelphia. Associate Professor of Applied Anatomy, University of Pennsylvania; Surgeon to the Episcopal Hospital; Surgeon to St. Joseph's Hospital; Surgeon to the Orthopedic Hospital and Infirmary for Nervous Diseases; Orthopedic Surgeon, Philadelphia General Hospital.

1892. Deaver, John B., M.D., 1634 Walnut Street, Philadelphia. Surgeon-in-Chief to the German Hospital, Philadelphia.

1910. Delatour, H. Beeckman, M.D., 73 Eighth Avenue, Brooklyn, N. Y. Clinical Professor of Surgery, Long Island College Hospital; Attending Surgeon, St. John's and Norwegian Hospitals; Surgeon-in-Chief, Jewish Hospital; Consulting Surgeon, Kingston Avenue Hospital, Brooklyn, St. Mary's Hospital, Jamaica and Hempstead Hospital.

†1882. Dennis, Frederic Shepard, M.D., F.R.C.S. Eng., 62 East Fifty-fifth Street, New York. Professor of Clinical Surgery, Cornell University, New York City; Visiting Surgeon to the Bellevue and St. Vincent's Hospitals; Consulting Surgeon to St. Joseph's Hospital, Yonkers, and Montefiore Home, New York City. *President*, 1894; *Vice-President*, 1887; *Member of Council*, 1889.

1910. Dowd, Charles N., A.M., M.D., 127 West Seventy-second Street, New York, N. Y. Professor of Clinical Surgery, Columbia University; Attending Surgeon, General Memorial Hospital, New York; St. Mary's Free Hospital for Children. New York; Junior Surgeon, Roosevelt Hospital, New York.

1901. Eliot, Ellsworth, Jr., M.D., 48 West Thirty-sixth Street, New York. Clinical Lecturer and Demonstrator of Surgery, College of Physicians and Surgeons, New York; Surgeon to the Presbyterian Hospital.

†1893. Elliot, John Wheelock, A.M., M.D. (Harvard), 124 Beacon Street, Boston. Surgeon to Massachusetts General Hospital.

1911. Elting, Arthur W., A.B., M.D., 119 Washington Avenue. Albany, N. Y. Professor of Surgery in the Albany Medical

ELECTED

College; Surgeon-in-Chief, St. Peter's Hospital; Attending Surgeon to the Albany and the Childs' Hospitals.

1896. ESTES, WILLIAM LAWRENCE, A.M., M.D., South Bethlehem, Pa. Director and Surgeon-in-Chief of St. Luke's Hospital; Lecturer on Hygiene at Lehigh University.

1898. EVE, DUNCAN, A.M., M.D., 700 Church Street, Nashville, Tenn. Professor of Surgery and Clinical Surgery, Medical Department, Vanderbilt University; Surgeon to the Nashville City Hospital.

1901. FERGUSON, ALEX. HUGH, C.M., M.D., 100 State Street, Chicago, Ill. Professor of Clinical Surgery in the Medical Department of the University of the State of Illinois; Professor of Surgery in the Post-Graduate Medical School of Chicago; Surgeon-in-Chief of the Chicago Hospital; Surgeon to Cook County Hospital for the Insane; Consulting Surgeon to Provident Hospital.

1899. FINNEY, JOHN M. T., M.D., 1300 Eutaw Place, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

1904. FRAZIER, CHARLES HARRISON, M.D., 1724 Spruce Street, Philadelphia, Pa. Professor of Clinical Surgery, University of Pennsylvania; Surgeon to the University Hospital.

1898. FREEMAN, LEONARD, B.S., M.D., 330 Majestic Building, Denver, Col. Professor of Surgery, Gross Medical College; Surgeon to the Arapahoe County Hospital and to St. Anthony's Hospital. *Vice-President*, 1908.

1910. GAGE, HOMER, A.M., M.D., 72 Pearl Street, Worcester, Mass. Surgeon to Worcester City Hospital, and to Memorial Hospital; Consulting Surgeon to St. Vincent Hospital.

†1882. GAY, GEORGE WASHINGTON, A.M., M.D., 665 Boylston Street, Boston, Mass. Senior Surgeon to the Boston City Hospital, Clinical Instructor in Surgery in Harvard University. *Member of Council*, 1882.

1892. GERRISH, FREDERIC HENRY, A.M., M.D. (Bowdoin), LL.D. (University of Michigan and Bowdoin), 675 Congress Street, Portland, Maine. Professor of Surgery in the Medical Department of Bowdoin College; Consulting Surgeon, Maine General Hospital.

1890. GERSTER, ARPAD G., M.D., CHIR.D., *President*, 34 East Seventy-fifth Street, New York. Professor of Surgery in the New York Polyclinic; Surgeon to the German and Mount Sinai Hospitals. *Vice-President*, 1908.

ELECTED

1906. GIBBON, JOHN H., M.D., 1608 Spruce Street, Philadelphia. Professor of Surgery, Jefferson Medical College; Surgeon to the Pennsylvania Hospital and the Bryn Mawr Hospital; Consulting Surgeon to the Woman's Hospital.

1906. GIBSON, C. L., M.D., 72 East Fifty-fourth Street, New York, N. Y. Professor of Clinical Surgery, Cornell University Medical College; Surgeon to St. Luke's and the City Hospitals.

1911. GREENOUGH, ROBERT B., A.B. (Harvard), M.D. (Harvard), 377 Beacon Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Assistant Visiting Surgeon, Massachusetts General Hospital,

1908. GUTHRIE, GEORGE W., M.D., 109 South Franklin Street, Wilkesbarre, Pa. Surgeon to the Wilkesbarre City Hospital; Consulting Surgeon to the Pittston Hospital and to the Palmerton Hospital.

1909. HALSTEAD, ALBERT E., M.D., 103 State Street, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Attending Surgeon to the St. Luke's and Cook County Hospitals; Consulting Surgeon to the Illinois Charitable Eye and Ear Infirmary; Lieut. Medical Reserve Corps, U. S. Army.

†1892. HALSTED, WILLIAM STEWART, B.A., M.D., 1201 Eutaw Place, Baltimore, Md. Surgeon to Johns Hopkins Hospital.

1909. HAMANN, CARL A., M.D., 404 Osborn Bldg., Cleveland, Ohio. Professor of Anatomy, Western Reserve University; Visiting Surgeon to Charity and City Hospitals.

1898. HARRINGTON, FRANCIS B., A.B. (Tufts College), M.D. (Harvard College), 201 Beacon Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

1900. HARRIS, MALCOLM L., M.D., 100 State Street, Chicago, Ill. Professor of Surgery, Chicago Polyclinic; Attending Surgeon, Alexian Brothers' Hospital, St. Luke's Hospital, and Maurice Porter Hospital for Children.

1895. HARTE, RICHARD H., M.D., 1503 Spruce Street, Philadelphia. Associate Professor of Surgery, University of Pennsylvania; Surgeon to the Pennsylvania Hospital, and Orthopedic Hospital and Infirmary for Nervous Diseases; Consulting Surgeon to St. Mary's, St. Timothy's, and Bryn Mawr Hospitals. *President*, 1910.

1898. HEARN, W. JOSEPH, M.D., 1120 Walnut Street, Philadelphia. Clinical Professor of Surgery, Jefferson Medical College

ELECTED

Visiting Surgeon to the Philadelphia Hospital; Consulting Surgeon to the Phœnixville General Hospital.

1899. Horwitz, Orville, M.D., 1721 Walnut Street, Philadelphia. Professor of Genito-urinary Surgery, Jefferson Medical College; Genito-urinary Surgeon to the Jefferson Hospital; Consulting Surgeon to State Hospital for Insane, and Jewish Hospital.

1909. Hotchkiss, Lucius Wales, A.B., M.D., 59 West Forty-eighth Street, New York. Adjunct Professor of Clinical Surgery, Columbia University; Attending Surgeon to Bellevue Hospital; Junior Surgeon to Roosevelt Hospital; Consulting Surgeon to J. Hood Wright Hospital, New York City.

1901. Huntington, Thomas W., A.B., M.D., 350 Post Street, San Francisco, California. Professor of Clinical and Operative Surgery, Medical Department, University of California; Visiting Surgeon to the City and County Hospital; Consulting Surgeon, St. Luke's Hospital, San Francisco. *Vice-President*, 1906.

1909. Hutchinson, James P., M.D., 133 South Twenty-second Street, Philadelphia. Surgeon to the Pennsylvania, Methodist, Children's, St. Timothy's, and Bryn Mawr Hospitals.

1901. Jacobson, Nathan, M.D., 430 South Salina Street, Syracuse, N. Y. Professor of Surgery, College of Medicine, Syracuse University; Surgeon to St. Joseph's Hospital.

1901. Johnson, Alexander B., M.D., 12 East Fifty-eighth Street, New York. Professor of Clinical Surgery, Cornell University Medical College; Attending Surgeon to New York Hospital.

1905. Johnson, Robert W., A.B., M.D., 101 W. Franklin Street, Baltimore, Md. Professor of Principles and Practice of Surgery, Baltimore Medical College; Surgeon to Maryland General Hospital, Church Home and Infirmary, and St. Agnes' Hospital.

1896. Johnston, George Ben, M.D., 405 East Grace Street, Richmond, Va. Professor of the Practice of Surgery and of Clinical Surgery in the Medical College of Virginia; Surgeon to the Old Dominion Hospital; Consulting Surgeon to the Richmond City Free Dispensary. *President*, 1904; *Member of Council*, 1907.

1901. Jonas, A. F., M.D., 454 Brandeis Building, Omaha, Nebraska, Professor of Surgery, Omaha Medical College; Surgeon to the Methodist Episcopal Hospital and to the Douglas County Hospital. *Vice-President*, 1906.

ELECTED

1910. Jopson, John Howard, M.D., 1824 Pine Street, Philadelphia, Pa. Professor of Surgery, Philadelphia Polyclinic; Associate in Surgery, University of Pennsylvania; Surgeon to Presbyterian Hospital, Children's Hospital, and Bryn Mawr Hospital.

1899. Kammerer, Frederic, M.D., 51 East Sixty-sixth Street, New York City. Professor of Clinical Surgery, Cornell Medical College; Surgeon to the German and St. Francis' Hospitals, New York.

*†1880. Keen, William Williams, A.M., M.D., LL.D., Hon. F.R.C.S. Eng. and Edin., 1729 Chestnut Street, Philadelphia. Emeritus Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College; Surgeon to the Jefferson Medical College Hospital; Consulting Surgeon to the Woman's and St. Agnes' Hospitals; Membre Correspondant Etranger de la Société de Chirurgie de Paris; Membre Honoraire de la Société Belge de Chirurgie. Ehreunitglied der Deutschen Gesellschaft für Chirurgie; Honorary Member, Clinical Society of London. *President*, 1898; *Vice-President*, 1892; *Member of Council*, 1899–1901.

1911. Killian, Otto G. T., M.D., 44 West 77th St., New York City. Professor of Clinical Surgery, Columbia University; Surgeon to the German Hospital.

1911. King, Alfred, A.B., M.D., Sc.D. (Colby), 610 Congress St., Portland, Maine. Lecturer on Surgery in the Medical School of Maine; Consulting Surgeon to the Maine General Hospital.

1901. Le Conte, Robert G., A.B., M.D., *Secretary*, 1530 Locust Street, Philadelphia. Surgeon to the Pennsylvania and the Bryn Mawr Hospitals; Consulting Surgeon to the Germantown and the Gynecean Hospitals.

1910. Lilienthal, Howard, A.B., M.D., 66 East Seventy-ninth Street, New York, N. Y. Attending Surgeon, Mount Sinai Hospital; Visiting Surgeon to Bellevue Hospital; Consulting Surgeon, Hospital for Joint Diseases, Jewish Maternity Hospital, and Har Moriah Hospital.

1908. Lothrop, Howard Augustus, A.M., M.D., 101 Beacon Street, Boston, Mass. Assistant Visiting Surgeon, Boston City Hospital; Instructor in Surgery, Harvard Medical School.

1910. Lund, Frederick Bates, M.D., 527 Beacon Street, Boston, Mass. Lecturer on Surgery, Harvard Medical School; Visiting Surgeon, Boston City Hospital.

ELECTED

1903. Lutz, F. J., A.M., M.D., 3337 Lafayette Place, St. Louis, Mo. Professor of Surgery, Medical Department, St. Louis University; Surgeon-in-Chief, Alexian Brothers' Hospital; Surgeon-in-Charge, Josephine Hospital.

1901. McArthur, L. L., M.D., 122 S. Michigan Boulevard, Chicago, Ill. Professor of Clinical Surgery, Post-Graduate Medical School; Assistant Professor of Clinical Surgery, Rush Medical College; Surgeon to St. Luke's and Michael Reese Hospitals.

1882. McGraw, Theodore A., M.D., 73 Case Street, Detroit, Mich. Professor of Surgery in the Detroit Medical College; Surgeon to St. Mary's and Harper Hospitals. *Vice-President*, 1896.

1903. McMurtry, Lewis S., A.M., M.D., LL.D., 542 Atherton Building, Louisville, Ky. Professor of Gynecology and Abdominal Surgery in the Medical Department, University of Louisville; Surgeon to the Louisville City Hospital.

1908. Mackenzie, Kenneth A. J., M.D., L.R.C.P., and L.R.C.S. Edin., 908 Corbett Building, Portland, Oregon. Professor of Operative Surgery, Medical Department Oregon State University; Surgeon to St. Vincent's Hospital, Portland, Oregon.

1904. MacLaren, Archibald, M.D., B.S., *Recorder*, 303 Lowry Annex, St. Paul, Minn. Professor of Clinical Surgery, University of Minnesota.

1906. MacMonagle, Beverly, M.D., 2000 Broadway, San Francisco, Cal. Surgeon to the Children's Hospital; Consulting Surgeon to the German Hospital.

*†1880. Marks, Solon, M.D., 136 Wisconsin Street, Milwaukee, Wis. Surgeon to St. Mary's Hospital. *Vice-President*, 1898.

1898. Martin, Edward, M.D., 1506 Locust Street, Philadelphia. Clinical Professor of Surgery, University of Pennsylvania and Woman's Medical College of Pennsylvania, Philadelphia; Surgeon to Philadelphia, St. Agnes', and Howard Hospitals.

†1895. Mastin, William McDowell, M.D., Northeast corner of Joachim and Conti Streets, Mobile, Ala. Surgeon to the Mobile City Hospital.

1895. Matas, Rudolph, M.D., 2255 St. Charles Avenue, New Orleans, La. Professor of Surgery, Medical Department, Tulane University; Professor of Clinical Surgery, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *President*, 1909; *Vice-President*, 1901.

1903. Mayo, Charles H., A.M., M.D., LL.D., Rochester, Minn. Surgeon to St. Mary's Hospital.

ELECTED

1899. Mayo, William J., A.M., M.D., D.Sc., F.R.C.S. Edin., LL.D. Tor., 427 West College Street, Rochester, Minn. Surgeon to St. Mary's Hospital. *Vice-President*, 1903.

*†1880. Mears, James Ewing, A.M., M.D., LL.D., 1535 Land Title Building, Philadelphia. *President*, 1893; *Recorder*, 1881–93.

1901. Meyer, Willy, M.D., 700 Madison Avenue, New York. Professor of Surgery in the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the German and New York Skin and Cancer Hospitals; Consulting Surgeon to the New York Infirmary for Women and Children.

1893. Mixter, Samuel Jason, S.B. (Massachusetts Institute of Technology), M.D. (Harvard), 180 Marlborough Street, Boston. Surgeon to Massachusetts General Hospital and to Carney Hospital; Consulting Surgeon to the Massachusetts Charity Eye and Ear Infirmary; Instructor in Surgery, Harvard University.

1896. Monks, George Howard, A.B. (Harvard), M.D. (Harvard), M.R.C.S. Eng., 67 Marlborough Street, Boston. Junior Visiting Surgeon, Boston City Hospital; Lecturer on Surgery, Harvard Medical School and Harvard Dental School.

1895. Moore, James E., M.D., 704 Pillsbury Street, Minneapolis, Minn. Professor of Surgery, University of Minnesota; Surgeon-in-Chief to the Northwestern Hospital. *Vice-President*, 1905.

1904. Mudd, Harvey G., M.D., Humboldt Building, St. Louis, Mo. Professor of Fractures and Dislocations and Clinical Surgery, Medical Department, Washington University; Surgeon to St. Luke's Hospital; Consulting Surgeon to the St. Louis City Hospital.

1906. Mumford, J. G., M.D., 29 Commonwealth Ave., Boston, Mass. Instructor in Surgery, Harvard Medical School; Visiting Surgeon to the Massachusetts General Hospital.

1902. Murphy, John B., A.M., M.D., 32 N. State Street, Chicago, Ill. Professor of Surgery, Medical Department of Northwestern University, Chicago Post-Graduate School and Hospital, and Chicago Clinical School; Attending Surgeon to Mercy Hospital, Cook County Hospital, and Wesley Hospital; Consulting Surgeon to the Alexian Brothers' Hospital and Hospital for Crippled Children.

1898. Murray, Francis W., M.D., 32 West Thirty-ninth Street, New York City. Professor of Clinical Surgery in Cornell University Medical College; Surgeon to the New York and St. Luke's Hospitals.

ELECTED

†1882. DE NANCRÈDE, C. B. G., A.M. (University of Pennsylvania), M.D., LL.D. (Jefferson), 504 South State Street, Ann Arbor, Mich. Professor of Surgery in the University of Michigan; Professor of Surgery, Dartmouth Medical College. *President*, 1908; *Vice-President*, 1889 and 1899.

1903. NEILSON, THOMAS R., M.D., 122 South Seventeenth Street, Philadelphia, Pa. Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children; Clinical Professor of Genito-urinary Diseases in the University of Pennsylvania.

1900. OCHSNER, A. J., B.S., F.R.M.S., M.D. ENG., 710 Sedgwick Street, Chicago. Professor of Clinical Surgery, College of Physicians and Surgeons; Surgeon-in-Chief of Augustana and St. Mary's Hospitals.

1900. OLIVER, J. C., M.D., 628 Elm Street, Cincinnati, Ohio. Dean and Professor of Operative Surgery, Miami Medical College; Surgeon, Cincinnati, Presbyterian, and Christ Hospitals.

1905. OVIATT, CHARLES W., M.D., 500 Algoma Street, Oshkosh, Wis.

†1882. OWENS, JOHN E., M.D., 1017–18 Venetian Building, Chicago, Ill. Professor of Principles and Practice of Surgery and Clinical Surgery in the Chicago Medical College; Surgeon to St. Luke's Hospital. *Vice-President*, 1900

1899. PARHAM, FREDERICK WILLIAM, M.D., 741 Carondelet Street, New Orleans, La. Professor of General, Clinical, and Operative Surgery on the Cadaver, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to Eye, Ear, Nose, and Throat Hospital.

1885. PARK, ROSWELL, A.M., M.D., 510 Delaware Avenue, Buffalo, N. Y. Professor of Surgery in the Medical Department of the University of Buffalo; Surgeon to the Buffalo General Hospital; Consulting Surgeon to the Fitch Accident Hospital. *President*, 1900; *Vice-President*, 1893; *Member of Council*, 1893–94, 1901–03.

†1893. PARMENTER, JOHN, M.D., 519 Franklin Street, Buffalo, N. Y. Professor of Anatomy and Clinical Surgery in the Medical Department of the University of Buffalo; Surgeon to the Sisters of Charity, Erie County, Fitch, Children's, and Emergency Hospitals; Assistant Surgeon to the Buffalo General Hospital.

1908. PECK, CHARLES HOWARD, M.D., 30 West Fiftieth Street, New York City. Associate in Surgery, Columbia University;

ELECTED

Attending Surgeon to French Hospital; Junior Attending Surgeon to Roosevelt Hospital.

1889. PILCHER, LEWIS S., A.M., M.D., LL.D. (Dickinson), 386 Grand Avenue, Brooklyn, N. Y. Professor of Clinical Surgery in the Post-Graduate Medical School, New York; Surgeon to the Methodist Episcopal Hospital, New York. *Vice-President*, 1893.

1904. PORTER, CHARLES ALLEN, A.M., M.D., 254 Beacon Street, Boston, Mass. Assistant Surgeon to the Massachusetts General Hospital; Instructor in Surgery, Harvard Medical School.

1896. POWERS, CHARLES A., A.M., M.D., *Treasurer*, Fourteenth and Stout Streets, Denver, Col. Professor of Surgery in the University of Denver, and Surgeon to the Denver City and County Hospital, and to St. Luke's Hospital; Consulting Surgeon to the Mercy Hospital and to the State Home for Children. *Vice-President*, 1903; *Member of Council*, 1908.

1908. PRIMROSE, ALEXANDER, M.B., C.M. EDIN., M.R.C.S. ENG., 100 College Street, Toronto, Canada. Surgeon to the Toronto General Hospital and to the Hospital for Sick Children, Toronto; Associate Professor of Clinical Surgery in the University of Toronto.

1886. RANSOHOFF, JOSEPH, M.D., F.R.C.S. ENG., *Vice-President*, 19 West Seventh Street, Cincinnati, Ohio. Professor of Anatomy in the Medical College of Ohio; Surgeon to the Cincinnati and the Good Samaritan Hospitals.

1887. RICHARDSON, MAURICE HOWE, A.B., M.D., 224 Beacon Street, Boston, Mass. Moseley Professor of Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *President*, 1902; *Vice-President*, 1897; *Secretary*, 1894–96; *Member of Council*, 1904.

1901. RIXFORD, EMMET, B.S., M.D., 1795 California Street, San Francisco, Cal. Professor of Surgery in Cooper Medical College; Surgeon to City, County, and Lane Hospitals. *Vice-President*, 1905.

1882. ROBERTS, JOHN B., A.M., M.D., 313 South Seventeenth Street, Philadelphia. Professor of Anatomy and Surgery in the Philadelphia Polyclinic; Surgeon to the Methodist and Jewish Hospitals. *Vice-President*, 1888 and 1894; *Treasurer*, 1892–93.

1898. RODMAN, WILLIAM L., A.M., M.D., 1904 Chestnut Street, Philadelphia. Professor of Surgery, Medico-Chirurgical College, Philadelphia.

ELECTED

†1882. Rushmore, John Dikeman, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Surgery in the Long Island College Hospital; Surgeon to the Brooklyn, St. Peter's, and the Eye and Ear Hospitals.

1909. Scudder, Charles L., M.D., A.B., Ph.B., 209 Beacon Street, Boston, Mass. Surgeon to the Massachusetts General Hospital; Lecturer on Surgery at the Harvard Medical School; Consulting Surgeon to the Melrose and Milford Hospitals.

1902. Shepherd, Francis J., M.D., 152 Mansfield Street, Montreal, Canada. Professor of Anatomy and Lecturer on Operative Surgery in McGill University, Montreal; Senior Surgeon to the Montreal General Hospital.

1905. Sherman, Harry M., A.B., M.D., A.M., 350 Post Street, San Francisco, Cal. Professor of Surgery in the University of California; Surgeon to St. Luke's Hospital, San Francisco; Orthopedic Surgeon to the Children's Hospital, San Francisco.

†1895. Souchon, Edmond, M.D., 2403 St. Charles Avenue, New Orleans, La. Professor of Anatomy and of Clinical Surgery, Tulane University; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *Vice-President*, 1899

1911. Stewart, Francis T., M.D., 311 S. 12th Street, Philadelphia, Pa. Professor of Clinical Surgery, Jefferson Medical College; Surgeon to Germantown Hospital; Out-patient Surgeon, Pennsylvania Hospital.

1909. Stillman, Stanley, M.D., 2201 Buchanan Street, San Francisco, Cal. Professor of Surgery, Cooper Medical College; Surgeon to Lane Hospital and City and County Hospital.

1909. Summers, John Edward, M.D., 618 Brandeis Theatre Bldg., Omaha, Neb. Surgeon to the Clarkson Memorial, the Wise Memorial, and the Douglass County Hospitals, Omaha, Neb.

1600. Taylor, William J., M.D., 1825 Pine Street, Philadelphia. Surgeon to the Orthopedic Hospital and Infirmary for Nervous Diseases, and to St. Agnes' Hospital; Consulting Surgeon to the West Philadelphia Hospital for Women.

1909. Thompson, James E., M.D., 3224 Broadway, Galveston, Texas. Professor of Surgery in the University of Texas Medical School; Surgeon to the John Sealy Hospital.

†1885. Thompson, J. Ford, M.D., The Cosmos Club, Washington, D. C. Professor Emeritus of Surgery, Medical Department, George Washington University.

ELECTED

†1882. TIFFANY, LOUIS MCLANE, A.M. (Cantab.), M.D., 831 Park Avenue, Baltimore, Md. *President*, 1895; *Member of Council*, 1883–89; 1896–97.

†1882. VANDER VEER, ALBERT, A.M., M.D., PH.D., 28 Eagle Street, Albany, N. Y. Dean of Albany Medical College; Professor of Didactic Abdominal Surgery and of Clinical Surgery in the Albany Medical College; Consulting Surgeon to St. Peter's Hospital; Attending Surgeon to the Albany Hospital. *President*, 1905; *Vice-President*, 1898; *Member of Council*, 1907.

1910. VANDER VEER, EDGAR ALBERT, PH.B., M.D., 28 Eagle Street, Albany, N. Y. Clinical Professor of Surgery, Albany Medical College; Attending Surgeon, Albany Hospital; Consulting Surgeon, Champlain Valley Hospital.

1902. VAUGHAN, GEORGE TULLY, M.D., 1718 I Street, Washington, D. C. Professor of Principles and Practice of Surgery, Georgetown University; Professor of Surgery and Genito-urinary Surgery, Washington Post-Graduate Medical School; Chief Surgeon, Georgetown University Hospital; Surgeon, Emergency Hospital; Consulting Surgeon, Government Hospital for the Insane, Washington, D. C.; Assistant Surgeon-General U. S. Public Health and Marine Hospital Service.

1891. WALKER, EDWARD W., M.D., 30 Garfield Place, Cincinnati, Ohio. Professor of Surgery, Miami Medical College.

1909. WALKER, JOHN B., M.D., 33 East Thirty-third Street, New York, N. Y. Surgeon to the Bellevue Hospital; Assistant Surgeon to the Hospital for Ruptured and Crippled, New York.

†1882. WARREN, JOHN COLLINS, M.D., LL.D. (Jefferson), HON. F.R.C.S. ENG. 58 Beacon Street, Boston, Mass. Professor of Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *President*, 1896; *Vice-President*, 1890; *Member of Council*, 1897.

1896. WATSON, FRANCIS SEDGWICK, A.B., M.D., 92 Marlborough Street, Boston. Surgeon to the Boston City Hospital; Instructor in Genito-urinary Surgery, Harvard Medical School.

†1889. WEIR, ROBERT F., A.M., M.D., HON. F.R.C.S. ENG., Cor Mem. Surg. Soc., Paris, 11 East Fifty-fourth Street, New York. Professor of Surgery in the College of Physicians and Surgeons, Columbia University; Surgeon to the Roosevelt Hospital. *President*, 1899; *Member of Council*, 1893–1896; 1901–03.

ELECTED

1892. WHARTON, HENRY R., A.M., M.D., 1725 Spruce Street, Philadelphia. Surgeon to the Presbyterian, Children's, and Methodist Hospitals.

†1882. WHITE, J. WILLIAM, M.D., PH.D., 1810 South Rittenhouse Square, Philadelphia. John Rhea Barton Professor of Surgery in the University of Pennsylvania.

1901. WOOLSEY, GEORGE, M.D., 117 East Thirty-sixth Street, New York City. Professor of Anatomy and Clinical Surgery, Cornell University; Surgeon to Bellevue Hospital; Associate Surgeon to the Presbyterian Hospital.

SENIOR FELLOWS.

Allis, Oscar H., M.D., 1604 Spruce Street, Philadelphia, Pa.

Barton, James M., M.D., 32 North New Hampshire Ave., Atlantic City, N. J.

Bradford, E. H., M.D., 133 Newbury Street, Boston, Mass.

Carmalt, William H., M.D., 87 Elm Street, New Haven, Conn.

Cheever, D. W., M.D., 557 Boylston Street, Boston, Mass.

Dennis, Frederic Shepard, M.D., F.R.C.S. Eng., 62 East 55th Street, New York, N. Y.

Elliot, John Wheelock, A.M., M.D., 124 Beacon Street, Boston, Mass.

Gay, George W., M.D., 665 Boylston Street, Boston, Mass.

Halsted, Wm. S., M.D., 1201 Eutaw Place, Baltimore, Md.

Keen, W. W., M.D., 1729 Chestnut Street, Philadelphia, Pa.

Marks, Solon, M.D., 136 Wisconsin Street, Milwaukee, Wis.

Mastin, Wm. M., M.D., Northeast corner Joachim and Conti Streets, Mobile, Ala.

Mears, James Ewing, A.M., M.D., LL.D., 1535 Land Title Building, Philadelphia, Pa.

de Nancrède, C. B. G., A.M., M.D., LL.D., 504 South State Street, Ann Arbor, Mich.

Owens, John E., M.D., 1201 Venetian Building, Chicago, Ill.

Parmenter, John, M.D., 519 Franklin Street, Buffalo, N. Y.

Rushmore, John D., M.D., 129 Montague Street, Brooklyn, N. Y.

Souchon, Edmond, M.D., 2403 St. Charles Ave., New Orleans, La.

Thompson, J. Ford, M.D., The Cosmos Club, Washington, D. C.

Tiffany, L. McLane, M.D., 831 Park Avenue, Baltimore, Md.

Vander Veer, A., M.D., 28 Eagle Street, Albany, N. Y.

Warren, J. Collins, M.D., 58 Beacon Street, Boston, Mass.

Weir, Robert F., M.D., 11 East Fifty-fourth Street, New York, N.Y.

White, J. William, M.D., Ph.D., 1810 S. Rittenhouse Square, Philadelphia, Pa.

HONORARY FELLOWS.

ELECTED

1907. BALLANCE, CHARLES ALFRED, M.D., M.S., University of London, F.R.C.S. ENG., 106 Harley Street, London.

1905. BILLINGS, JOHN S., M.D., 40 Lafayette Place, New York, N. Y.

1891. BRYANT, THOMAS, F.R.C.S. ENG., 65 Grosvenor Place, Grosvenor Square, W., London.

1891. CHIENE, JOHN, F.R.C.S. EDIN., M.D. EDIN., 26 Charlotte Square, Edinburgh, Scotland. Professor of Surgery in the University of Edinburgh.

1885. CZERNY, PROF. DR. VINCENT, 25 Sophien Strasse, Heidelberg, Germany. Professor of Surgery in the University of Heidelberg.

1911. VON EISELSBERG, FREIHERR ANTON, Vienna, Austria. Professor of Surgery, Vienna University.

1910. FRIEDRICH, PROF. P. L., 19 Bahnhofstr., Marburg, Germany. Professor of Surgery, University of Marburg.

1890. HORSLEY, SIR VICTOR ALEXANDER HADEN, F.R.C.S. ENG., 25 Cavendish Square, W., London.

1894. KOCHER, PROF. DR. THEODOR, 25 Villette, Berne, Switzerland. Professor of Surgery, University of Berne.

1885. LISTER, LORD JOSEPH, M.B., London, O.M., F.R.C.S. ENG., D.C.L., LL.D., 12 Park Crescent, London, W. Professor of Clinical Surgery in King's College.

1894. MACEWEN, SIR WILLIAM, M.D., M.B., M.S., 3 Woodside Crescent, Glasgow, Scotland.

1908. MOYNIHAN, B. G. A., M.S. LOND., F.R.C.S., 33 Park Square, Leeds, England. Surgeon to the Leeds Infirmary.

1907. MYLES, SIR THOMAS, M.D., F.R.C.S.I., 33 Merrion Square, N., Dublin, Ireland.

1907. POZZI, PROFESSOR S., Avenue de Jena, Paris, France. Professor of Surgery, University of Paris.

1903. Robson, A. W. Mayo, M.D., F.R.C.S., D.Sc., 8 Park Crescent, Portland Place, London, W., England. Vice-President, Royal College of Surgeons of England; Hunterian Professor of Surgery and Pathology.

1882. Smith, Stephen, A.M., M.D., LL.D., 574 Madison Avenue, New York. Professor of Clinical Surgery in the University Medical College of New York; Surgeon to the Bellevue and St. Vincent's Hospitals. *Vice-President*, 1890.

1907. Trendelenburg, Prof. Dr. F., Leipzig, Germany. Professor of Surgery, University of Leipzig, Germany.

REPORT OF THE COMMITTEE ON NECROLOGY

WILLIS GOSS MacDONALD, M.D., LL.D.

Dr. MacDonald was born at Cobleskill, New York, April 11, 1863. He was a descendant of Benjamin MacDonald, who came to this country from Scotland, in 1759, first locating in Coeymans, N. Y., and later in Schoharie County. Dr. MacDonald was graduated from the Cobleskill Free Academy in 1878, attended the Albany State Normal School, and Cornell University. He was graduated from the Albany Medical College in 1887, and as a student was noted for his thorough industry, for his original observation, and independent line of thought. After graduation, for eighteen months he was house surgeon at the Albany Hospital, after which he spent a year at the University of Berlin, where he took special courses in surgical pathology, bacteriology, and general surgery, coming directly under the instruction of Professors August Martin, Ernest von Bergmann, and their assistants. Later he spent some time in the hospitals of London, and quite frequently would take a trip abroad for a few months, visiting Germany and spending considerable time with Dr. Kocher, at Berne, of whom he was very fond and whose surgery he admired greatly. After locating in Albany, he was for some time assistant to his former preceptor, Dr. Albert Vander Veer, and became successively instructor, lecturer, and finally professor of abdominal and clinical surgery in the Albany Medical College, which position he held at the time of his death. Dr. MacDonald died of pneumonia at his home in Albany, on December 30, 1910, after but a few days' illness. At the time of his death he was attending surgeon at the Albany Hospital; consulting surgeon to the General Hospital at Westfield, Mass.; consulting surgeon and president of the staff of the South End Dispensary, Albany; had served as a member of the Board of Education of the city of Albany; and was one of the original Board of Trustees of the New York State Hospital for Incipient Tuberculosis at Raybrook, New York. He was surgeon in the United States Volunteers, with the rank of major, in the Spanish-American War. He was a member and ex-president of the Medical Society of the County of Albany, also of the Medical Society of the State of New York; a member of the

International Congress of Surgeons; a member of the American Association of Obstetricians and Gynecologists, of the Pan-American Medical Congress, and the Tenth, Eleventh, and Twelfth International Medical Congresses. He was a member of the Fort Orange, Albany, and University Clubs. Dr. MacDonald was a man of predominating influence and made his impression upon the civic and professional organizations with which he was connected. He was elected a Fellow of the American Surgical Association in 1901, while absent in Europe, and he often stated that of the various honors that had come to him none gave him so much pleasure as his election to this organization. Possessed as he was of a keen understanding and knowledge of surgical pathology and bacteriology, his papers, of which he prepared several for the Transactions of the American Surgical Association, were always well received. He had a remarkable capacity for retaining knowledge, of holding it in reserve, and imparting it in a forceful manner. Truly, he was one of the eminent surgeons of his day. His writings were well received, greatly appreciated, and standards of expression in all subjects upon which he wrote. Although an exceedingly fleshy man, and possessed of short, fat fingers, yet he was a masterful operator and original in the application of his knowledge of surgery. His early surgical experiences were obtained at a time when the old surgery was passing away and antiseptic methods and bacteriology were claiming the attention of all thoughtful workers in the profession. In this atmosphere of advanced abdominal surgery he loved to do his studying, to make his observations, to perform such experiments as aided him in his surgical conclusions, and he was looked upon by a host of warm friends as a thorough surgeon whose opinion was greatly respected. Honors came to him and were well deserved. He was an extremely successful student in medico-legal work, and not infrequently employed as a medical expert in some of the most complicated cases in the courts in and about Albany. Dr. MacDonald was a most fluent conversationalist, told a story effectively and pointedly, and at times his illustrations in the court room were so exceedingly plain as to make a great impression upon the jury. The frailties of human nature he had; he was very forceful in his discussions, always had a loyal affection for his friends, and it can be truly said he retained the respect of those whom he opposed.

He will be greatly missed in our future meetings. His presence, his conversation we regret is no longer to be our enjoyment. We admired and loved him for the excellent work he did while with us.

A. V. V.

DE FOREST WILLARD, A.M., M.D., PH.D.

DE FOREST WILLARD, the son of Daniel H. and Maria Deming Willard, was born at Newington, Connecticut, on March 23, 1846. At eighteen months he had an acute attack of anterior poliomyelitis, which produced the usual atrophy and paralytic talipes equino varus, and in later years tenotomy was done by Dr. D. Hayes Agnew. The shortening of his leg required the use of a cane all through his life.

Having graduated from the Hartford High School in 1863, he entered Yale, but was obliged to abandon his college course on account of trouble with his eyes. In September, 1863, he came to Philadelphia and began the study of medicine at the Jefferson Medical College under Dr. Joseph Pancoast and Dr. Samuel D. Gross. In 1864 he matriculated at the University of Pennsylvania, but soon dropped his studies and went to the front under the auspices of the United States Sanitary Commission. The exigences of the last days of the war were such that he was put in charge of wards, and did a surgeon's work at Petersburg, City Point, and Richmond.

After the close of the war he had a severe attack of typhoid fever, narrowly escaped with his life, and was unable to resume his studies until 1866. Graduating from the University, he at once entered the Philadelphia Hospital as resident, and after serving fifteen months, commenced private practice in Philadelphia.

In 1877 he was given a Lecturership at the University of Pennsylvania, and started the orthopedic work there at that time. The growth of the department was so rapid that in 1882 it became apparent that provision must be made for a large ward. He accordingly raised the money for the establishment of the Agnew Ward for Crippled Children, and furnished it with every appliance pertaining to the work, among them an unusually equipped gymnasium, where thousands of treatments are given every year. The ward was opened in 1897, and has been constantly filled ever since. His clinics were always crowded, patients coming from every State in the Union. Dr. Willard was made full Professor of Orthopedic Surgery in 1903. During the forty-three years that he was connected with the University he served without salary.

His work at the Presbyterian Hospital was in general surgery, and included every branch of work and every major operation. He served the hospital for thirty-five years, nine years as Pathologist, and twenty-six years as Attending Surgeon. Upon his resignation in 1907 he was elected Consulting Surgeon.

When Mr. Widener first thought of the Industrial School for Crippled Children, he consulted Dr. Willard, and the latter spent

much time and thought in planning all the details of the buildings, the work of educating the children, and the necessary appliances for treating them. The school was opened in 1906, and Dr. Willard made its Surgeon-in-Chief. It is one of the most beautiful and complete institutions in Philadelphia.

Dr. Willard was throughout his life a constant, voluminous, and concise writer, covering every field in surgery. It must have been a satisfaction to himself and a gratification to his family, as it certainly was fortunate for the profession and humanity, that his life was prolonged until his book on *The Surgery of Childhood* was completed. In this work is given the large and fruitful experience of one singularly devoted to his specialty. His own affliction in childhood was his inspiration, and it may truly be said that in suffering himself he lived to enjoy the unspeakable reward and pleasure of relieving the physical pain and mental anguish of many others similarly afflicted. If everyone with an infirmity could bear it as cheerfully and with such optimism and Christian resignation as Dr. Willard did, so as really to convert it into a blessing to humanity, then indeed would the whole world be brighter and sweeter and the teachings and sacrifices of Him who came upon earth that all might be saved would be brought nearer home to us all.

Dr. Willard was a man of commanding appearance, marked cordiality of manner, and prodigious energy. He was loved as a man, a practitioner, and a teacher, and filled a great variety of positions of honor and responsibility. He was President of the Philadelphia County Medical Society, the Philadelphia Academy of Surgery, the American Orthopedic Association, the Chairman of the Surgical Section of the American Medical Association, and President of the American Surgical Association. For forty years he was a member of the Presbyterian Church; for twenty-five years a Trustee of the Second Presbyterian Church, and an Elder for fifteen years.

Dr. Willard married, in 1881, Miss Elizabeth Porter, and is survived by her and their son, De Forest Porter Willard, who has already become actively interested in surgical work, being the assistant of Professor Edward Martin at the University of Pennsylvania.

It was with deep regret that Dr. Willard's many friends learned of his death on October 14, 1910. He was so appreciated by the congregation of the Second Presbyterian Church, which he served for so many years, that a memorial service largely attended by members and physicians was held on May 8, 1911, in the church. Suitable addresses were made by the Rev. Winthrop B. Green, Professor Edward Martin, of the University of Pennsylvania, and Professor Hugh Black, of New York. All spoke feelingly of the beautiful life and beneficent work of De Forest Willard. W. L. R.

THE PRESIDENT'S ADDRESS.

By RICHARD H. HARTE, M.D.,
PHILADELPHIA.

GENTLEMEN AND FELLOWS OF THE AMERICAN SURGICAL ASSOCIATION:

It is with sincere humility that I address you as the presiding officer of one of the most representative surgical bodies in the world. When I recall the distinguished men who have preceded me and see about me many whose superior services and attainments, no less than their just appreciation by their Fellows and the public, have won for them this high office with which, in your kindness, you have honored me, I am more than ever sensible of unworthiness to assume the responsibilities of so important an honor, and my inability to discharge them.

As your executive, and on behalf of the officers and the Committee of Arrangements, it is my most pleasant privilege to extend a hearty welcome to all, particularly to the friends who have come from our Mother Country across the sea and who honor us with their presence, and also to the Fellows who come to enrich our records with a ripe harvest of mature observation gleaned from the boundless field of surgery.

The personal regard and confidence of my Fellows in this Association, expressed in so honoring me, have emboldened me to ask your indulgence, while I present briefly some topics which I feel merit our thoughtful consideration.

Before proceeding, however, to the matters pertaining to our professional work, I would take time to pay with you tribute to our beloved and honored colleagues who have died since our last meeting in Washington. We have sustained severe losses in the death of five of our Fellows—all of them most interested

and active in the internal affairs of the Association—to whom their valuable advice and counsel are forever lost. I shall not attempt to mention here more than their names and the offices they have held, but shall leave your Committee on Necrology to deal more fully with the virtues and work which we have long since learned to associate with these names we love so dearly—of De Forest Willard, President and Recorder; of Nathaniel P. Dandridge, President and Treasurer; of John C. Munro, Vice-President; of Willis G. MacDonald, Vice-President; and of James Bell, a most valued contributor to our TRANSACTIONS.

In passing, I wish to note some of the history making we have done in the year just closed. In this connection, I refer especially to the meeting in Great Britain of the Society of Clinical Surgery—an organization whose membership is almost entirely made up of Fellows of this Association. The visit of this Society, from both professional and social points of view, was so successful as to be a notable landmark in the lives of all of those who participated in these unusually interesting and profitable meetings. The sincere cordiality of the reception extended to the Society by the Profession abroad has suggested to the speaker that a similar excursion might be undertaken by this Association, whose welcome is certainly assured whenever the time and inclination offers for a visit of that character, which, owing to the complete facilities for travelling, would involve little, if any, more time and inconvenience than a transcontinental excursion.

The effect of this meeting, or series of meetings, held for the Clinical Society, was very manifest. Quite as travel and observation have a noticeable effect upon individuals, so this visit had its effect on the Society—of broadening its views, especially upon the standardization of surgical technique and general operating-room management—as, in every condition dealt with, there was some phase of the technique which could to advantage be imitated or avoided.

Certain localities were found rich in a special variety of disease or injury, arising from the peculiar habit or occupation of people in the community, as was exemplified by the peculiar injury to the knee-joint, known as "miner's knee," so frequently seen among the mining population of New Castle, and which has been

so accurately described by Mr. Morrison, of the Royal Infirmary in that city, where I am informed they have had about sixteen hundred operations for this peculiar form of injury. Such an enormous experience in this branch of surgery alone is well worth a special visit.

The afternoon spent in Mr. Jones' clinic in Liverpool, although most orthopedic in character, I think was a revelation to all who were so favored as to attend, and it was also an inspiration to the general surgeon, in that it demonstrated that a great deal of our bone work can be handled by the general surgeon as well as by the specialists.

Again, I might mention the wonderful clinic of Mr. Stiles, especially in his dealing with the great mass of tuberculous material which finds its way to his clinic and which he deals with in such a masterly way.

I have merely referred briefly to some of the provincial clinics, as our experiences in London and Edinburgh, from clinical, social, and historical points of view, were so interesting and varied that time alone forbids my doing any more than mentioning these two cities so rich in everything which naturally interests and endears them to the American surgeon.

I may not here go into further details concerning this memorable, interesting, and instructive visit to some of the cities of Great Britain. But I look forward with anticipation to the day when our Association may see its way to cross the ocean and to avail itself of such privileges, of observing the work of the best workers in the great English school of surgery. This may appear to some as the imagination of a mere dreamer, but I assure you, gentlemen and dear Fellows, that the time is not far distant when we shall be holding occasional meetings in Great Britain and our English colleagues will be paying visits to us in America.

This mutual exchange of ideas, by personal contact and observation, will have a much more broadening influence on the great English-speaking school of surgeons than all the surgical papers that could be written, read, and discussed in a decade. We must not forget that we are not the only originators of new ideas, but that this plan was carried out when the British Medical Association met a few years ago in Montreal.

And now, I shall consume but little of your time in the consideration of some phases of the treatment of fractures of the long bones; not new phases at all, nor anything which you do not know full well, but which many of us seem to have forgotten; or at least to have relegated to others, on account of pressure from the vast amount of material forced upon us as operating surgeons and teachers.

The question primarily is: Are we obtaining the most desirable results in the treatment of fractures of the long bones, in view of the appliances at our command, in the way of aseptic technique and the unlimited advantages of the Röntgen laboratory, which today form an essential part of the armamentarium of our modern hospitals?

I cannot help feeling that we, as surgeons and teachers, are not fully utilizing our talents nor all of the advantages at our command. Neither are we devoting as much time and care as we should to the thorough instruction of students and internes in our schools and hospitals in this very important branch of surgery. Many at first may be disposed to question this statement, but I hope to elicit your thoughtful consideration of what, to my mind, seems most important.

There is lack of interest and a feeling that the subject of fractures is so old that it will almost take care of itself. Today other fields of surgery—for example, the abdomen, bloodvessels, and thorax—offer such a large and attractive variety of opportunities for original research and investigation, and the results are so brilliantly and quickly achieved, that it does not seem strange that the slow physiological processes pertaining to the repair of a broken bone should be relegated to the care of those whose time is less occupied, and who are willing to accept this responsibility of what they have been taught to consider a very humble and almost unimportant branch of surgery.

Teachers and surgeons generally appear to be apathetic, and are disposed to leave these cases to the care of assistants or house officers, and it is only after a case has progressed badly that sufficient interest is aroused to demand action on the part of the surgeon.

Not only is less time given to teaching this important and

interesting subject, but the study of the clinical aspects of the case, which was thought so essential formerly for a correct diagnosis, has given way to the more easy laboratory findings. The student of fractures today feels that an *x*-ray report will reveal to him in a moment, and with less trouble, what a careful clinical study, requiring a much greater expenditure of time, would show.

Permitting this impression to grow in the minds of students has had its influence indirectly upon the treatment of fractures in general, and it is only too apparent that the rising generation is lacking in much of the skill and resourcefulness which characterized the older surgeons in the diagnosis and treatment of these injuries.

The older Fellows well remember how much time, care, and attention were formerly devoted by lecturers to the consideration of fractures; they formed, in fact, one of the most important topics in a course on surgery, which always embraced a very complete classification *of* and exhaustive instruction *in* the mechanism of fractures, the displacing element played by the muscles, and what should be done to obviate and correct these displacements; and practical instruction looking to acquiring a thorough knowledge of the art of bandaging and how to apply accurately all forms of fracture dressings: First in the bandaging of mannikins, and later on of human subjects, so that the student was able to properly apply all sorts of the roller bandages. He would have them applied to his own person and so form an accurate conception of the amount of pressure that is necessary to retain a splint to the injured part, or to control the spasms of an irritated or bruised muscle. Thus equipped and informed, the young surgeon, no matter how youthful his appearance, was able to convince his patients that he was at least master of this branch of surgery.

Contrast this with what we see in so many of our house officers today, many of whom have been appointed after a most vigorous competitive examination, in which they may have displayed enviable knowledge of bacteriology and hematology, and may have been able to cite quite glibly all of the intricacies of the Wassermann reaction, but who have hardly the slightest idea

of how a splint should be padded or prepared for a fracture of the forearm; much less exactly how it should be applied; and (what is infinitely worse) when instructed, will invariably relegate this important part of the routine treatment of fractures to the ward nurse, who may be but little more advanced than the probationer.

It would appear to the careful observer that the surgeon of today depends too much upon laboratory findings, and that a careful clinical study of the aspects of a case is too frequently neglected.

For the *x*-ray, it must be said that our knowledge of fractures appears to have been limited before the era of its development, and, as the natural result of this marvellous invention, to have enormously advanced, and the entire subject to have been transformed so that we have a new generation growing up who cannot consider fractures except in the light of a skiagraph, nor tolerate anything which partakes of the nature of the older methods of diagnosis.

Good *x*-ray work has been done in the last decade, adding much to the data on the subject of fractures, demonstrating that fractures occur in types—and very definite types at that. It has proved that many types which were supposed to be rare are common, as comminuted fractures of the lower end of the radius; fracture and luxation of the carpus, and fracture of the greater tuberosity of the humerus. It has disproved the prevalence of such injuries as coracoid fracture of the scapula and fractures of the acromion process.

It has placed and classified fractures about the elbow-joint, especially in children, and has demonstrated many of the injuries to be of an epiphyseal nature and not of the type of T-fracture so often seen in adults.

Thus, in teaching us *what* to look for, it also has, or should have, taught us *how* to look.

I do not wish for one moment to decry the use of the *x*-ray, but to consider the time and place for its employment. Much has been said about the importance of having every case skiagraphed for the purpose of making a diagnosis, and about its being criminal to omit the picture. To my mind, it is often unnecessary and impracticable, and may often inflict considerable

hardship on the patient of limited means. It does little more than satisfy certain curiosity without really adding data for the future management of the case. Of course, in obscure and special conditions, a preliminary skiagraph may be profitably employed, and should be. The *x*-ray in all its phases will prove an invaluable aid to study, a condemning judge to the careless surgeon, and a constant and inspiring stimulus to improved technique.

The time for the *x*-ray picture is after a thorough clinical study and accurate reduction have been made, under an anesthetic (if necessary), and appropriate dressings placed on the injured part. The skiagraph can then be taken, not primarily for the purpose of diagnosis, but for the assurance of an accurate and proper coaptation of the fragments.

In other words, the time to employ the *x*-ray is preferably after and not before reduction, thus acting as a check to diagnosis, correction of position, and prognosis.

I wish to emphasize the importance of having fractures skiagraphed in planes crossing each other at right angles, or else of having a stereopticon plate prepared, which is of great advantage. Otherwise many fractures will escape detection and leave the surgeon only clinical data for the future management of the case, which will be very embarrassing to the man who places absolute confidence in the result of his *x*-ray findings.

I feel that a general review of the subject cannot be dismissed without some reference being made to the so-called open treatment of simple fractures, as advocated by some of the more radical members of the profession, and so strongly advised by Mr. Lane, of London, and Dr. Huntington, of San Francisco.

In this respect, medical men today seem distinctly divided into three groups:

1. Those who never or rarely ever operate at all, who may be called the ultraconservatives.

2. Those who operate on nearly every case, who might be designated as extremists in this branch of surgery.

3. The conservatives, who operate on properly selected cases, after it is definitely proved that other methods of treatment are not expedient, and that proper reduction cannot be accomplished

nor the ends of the fragments held in position without some operative procedure.

From the first group, we get the greatest number of distinctly bad results and the largest number of suits for malpractice.

From the second group, if uniformly followed, we would undoubtedly have the greatest mortality.

From the third or more conservative group, we have, I think, the best results consistent with a low mortality.

The operative or open treatment of simple fractures is, in itself, a very large subject in which many things have to be considered beyond the mere approximation of the ends of the bones and their permanent retention by some mechanical device, as catgut tendon, wire, nails, plates, etc., and should only be considered for a class of patients that give promise of being good operative risks.

And, before going farther, I want to pay tribute to the very excellent pioneer work done in this city (Denver) by our late colleague, Dr. Parkhill, who devised some ingenious clamps and screws for retaining in position the fragments in fractures of the long bones. His method has been slightly modified by some, but the far-seeing underlying principle still remains the same, and offers a very satisfactory and safe method for dealing with certain types of fractures demanding operative interference.

It stands almost without reasoning that, in order to obtain a good functional result, after fracture, the ends of the bone should be brought in direct relation with each other, and most of the cases in which we fail to obtain union are those in which the fragments are widely apart and not infrequently separated by a fragment or spicule of bone, a tendon, a muscle, or piece of fascia. No satisfactory attempt at repair will take place until all barriers are removed by operation, the fragments retained in position by some mechanical device, and the limb kept at rest by means of suitable splints and bandages. Everything should be done to make the patient's physical condition the best, and, last but not least, the hygiene of the skin of the injured member should be kept in the highest state of efficiency by frequent ablutions of soap and water, alcohol, and light massage.

The time for operating, if found necessary, is either as soon

after the injury as possible, and before the parts are infiltrated with serum and before muscular contraction has taken place, or after the inflammatory condition has subsided (which is usually during the second week). To wait longer involves muscular contraction and adhesions, which add much to the technical difficulties of the operation. Moreover, distinct changes are occurring in the ends of the fragments, which often tend to delay union by blocking up the bone channels with lime salts—a condition frequently seen, though oftener in cases of old ununited fractures.

I do not endorse the methods of my more radical friends who can hardly look at a fracture except in the light of an operation, and who use some form of metallic plate which is retained in position by drilling the bone and inserting screws, nails, wire, or some extraneous substance, for the following reasons:

If this entailed no risk or bad effects, this method would certainly offer all that could be desired, so far as the approximation and retention of the fragments are concerned. But by pursuing this method, as routine treatment, the patient has his simple fracture converted into a compound one (in itself always an element of risk). The ends of the fragments have to be dealt with rather vigorously by introducing screws for the plates, which have to be removed by a second operation and the presence of these foreign bodies interferes with the bone's nutrition and frequently causes considerable necrosis and caries, which are disclosed at the time of their removal.

Before dismissing this branch of the subject, I wish to emphasize the importance of early operative interference in cases where the ends of the bones cannot be properly adjusted, or where there is danger of non-union, or where bad functional result follows the ordinary procedure. Where any of these conditions exist, the sooner the case comes to operation, the better for the patient.

It must also be remembered that these operations are often most difficult, requiring special types of instruments and a thorough surgical technique (which is not in the province of every man who considers himself a surgeon), and that the wounds are more prone than any other class of wounds to infection, and the risk to life and limb is thereby proportionately increased.

In conclusion, I want to try and bring to the minds of the Fellows of this Association the importance of more thorough instruction in the routine treatment of fractures in general, by men of large surgical experience, instead of relegating it to mere novices, because students are very astute and quickly grasp the relative importance of any subject by the class and character of men to whom its instruction is intrusted.

If this suggestion is faithfully carried out, a much smaller percentage of cases will be offering themselves for operation and less of our surgery will be reviewed in the courts for either real or imaginary lack of surgical skill.

EPISPADIAS IN THE FEMALE AND ITS SURGICAL TREATMENT, WITH A REPORT OF TWO CASES.

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Permit me, Mr. President, in the first place, to thank you and this distinguished Association for the honor you have done me in inviting me to this meeting. It is, I can assure you, an honor of which I am deeply sensible, and the distance I have travelled in order to attempt to fulfil the onerous task which it entails will, I hope, testify to you how much I appreciate it.

I was induced to choose "Epispadias in the Female" as the subject of my communication, because I felt it possible that many of the members of this Association might not be familiar with the condition; and I was further encouraged in the choice because it enables me to bring before you gentlemen who are all expert surgeons a method of transplanting the divided ureters into the intestine, which, I believe, will commend itself, not only on account of its simplicity, but also because it seems to me to be physiologically sound, and to be more likely to prevent kidney complications than the methods hitherto employed.

Before describing the operative technique, let me give a brief record of the two cases which have come under my care.

Case I.—Katharine D., aged three years, admitted to the Royal Edinburgh Hospital for Sick Children, September 14, 1907, on the recommendation of Dr. Craig, Cowdenbeath, Scotland. The mother complained that the child had never

been able to retain her water day or night since birth, that she was constantly wet, and that it was very difficult, especially in cold weather, to prevent the skin from becoming excoriated. Apart from the epispadias, the child was otherwise perfectly healthy, well nourished, and of a cheerful disposition. There were five other children, all of whom were healthy.

FIG. 1

On examining the vulva the following condition was revealed: The fatty cushion was somewhat deficient at the centre of the mons veneris, its place being taken by a broad and rather shallow depression covered with normal skin, which was freely movable upon the subjacent symphysis. With the thighs approximated, the furrow, which was directed downward, led to a triangular opening, bounded below by the closely approximated halves of the split clitoris, and laterally by two mucocutaneous folds (one-half of an inch in length and one-quarter of an inch in breadth) which passed upward and outward from each half of the clitoris

immediately internal and parallel to the upper part of the diverging labia majora. The latter were themselves well developed, but instead of meeting to form the anterior commissure, they too diverged anteriorly and merged insensibly into the outer part of the mons veneris. Posteriorly, the labia majora were normal. When the thighs were separated so as to open up the vulva, the two halves of the clitoris became widely separated and the dorsal wall of the latter was then seen to be covered with mucous membrane very slightly plicated longitudinally,

FIG. 2

and forming an open trough or gutter, three-quarters of an inch in length, continuous above with the skin covering the upper part of the symphysis pubis. Below, this mucous trough led into the orifice of the urethra, through which the little finger could easily be introduced into the bladder. Below and behind this large meatus the vulva was quite normal, the ostium vagina being surrounded by a circular hymen and separated from the meatus urinarius by a septum, one-third of an inch in breadth.

Returning to the clitoris, each half of that body was surrounded for the upper three-fourths of its circumference by a small horseshoe fold of mucous membrane which represented the divided prepuce. This fold was continuous externally with the two mucocutaneous folds which formed the lateral boundaries of the short infundibuliform canal leading to the urethral orifice. Extending backward from each half of the clitoris was the labium minus which appeared to be rather smaller than normal.

From the above description, it will be seen that when the thighs were approximated, the most striking abnormality was the absence of the anterior commissure, its place being occupied by a short infundibuliform passage from which the urine constantly escaped. With the vulva opened out one was at once struck by the large size of the urethral orifice, below and on either side of which was the half of the split clitoris.

As to the exact nature of the deformity, it is evident we have to do with an arrest of development of the dorsal wall of the urethra; and from the large size of the urethral orifice, combined with the entire absence of resistance encountered by the finger when introduced into the bladder, it is evident also that the deformity involves the vesical sphincter; hence the incontinence.

Case II.—The second case was that of Anna McK., aged seven years, recommended to the Royal Edinburgh Hospital for Sick Children by Dr. Politachi, anesthetist to the Out-patient Department.

It is not without interest to note that this second case was recommended by Dr. Politachi, who being anesthetist to the Out-patient Department, had become familiar with the clinical features and subsequent history of the case above recorded. The fact that he should have so soon come across a similar condition in his own practice would seem to indicate that the condition has probably been overlooked, and that it is not so rare as the literature would lead one to suppose. It is more than probable that such cases are being treated as the ordinary incontinence of urine in childhood.

The lesson to be learned from these cases is that an examina-

tion of the vulva should be made as a matter of routine in all girls suffering from urinary incontinence, and that if the incontinence has existed since birth, and has been diurnal as well as nocturnal, epispadias should be thought of. If this advice were followed, more cases would soon be discovered.

Within a few months of demonstrating these two cases to the Society of Physicians at the meeting which was held in Edinburgh, one of the members, Dr. Macalistair, of Liverpool, kindly told me that he had come across a case in a young woman in the Out-patient Department of the Liverpool Royal Infirmary, but unfortunately he has since lost trace of her.

The history in the second case was that nothing abnormal was noticed about the child until it was eighteen months old, when the mother observed that its clothes were constantly soaked with urine, and that the skin was very red and sore. The mother attributed the condition to the child having caught a chill in consequence of her having discarded a flannel binder. Patient had always been thin, but otherwise healthy. She was, however, of a very timid and emotional disposition, due it is said to the father having taken an antipathy to the child on account of her deformity. There were five other children, all healthy.

The child presented precisely the same malformation as in the case already described, except that the urethral orifice was relatively smaller, and did not admit the finger quite so readily. While in the recumbent posture the child could retain the water for an hour or two, but during the daytime it constantly dribbled away.

For an explanation of the developmental anomaly responsible for the various degrees of epispadias and extroversion of the bladder, we are indebted to the valuable monograph of Dr. Berry Hart, of Edinburgh, who writes as follows:

"The cloacal membrane, as was first pointed out by Kolliker, and afterward confirmed by others, has at one time no mesoblast, and is thus a part structurally weak. The upper boundary of this membrane is the navel, and its lower the junction of end-gut and entodermal cloaca. In the adult this lower point

is on the perineal body in front of the anus, as in a rare malformation, viz., persistent end-gut in a female child; I found this part of the gut attached to skin in front of the anus. In the adult, therefore, the cloacal membrane is represented by the mesial region from navel back to perineal body—the anterior boundary of bladder, pubes, urethra, and vestibule. . . .

"The best explanation of extroversion is afforded by the facts now known as to bladder development and the cloacal membrane. The bladder in the human female is not developed from allantois except at its apex, but is derived along with the urinogenital sinus from the anterior division of the entodermal cloaca. This cloaca has the cloacal membrane as its anterior boundary, and as this boundary has no mesoderm at one period, it may yield or cleave. This yielding, if complete, necessarily exposes all that is derived from the anterior gut division, viz., bladder, urinogenital sinus, lower third of vagina as in Champney's case. Less degrees of fissure in linear extent or depth give the other lesions. These are therefore explained, as Keibel has so well shown, by the actual development of the parts plus some bursting or dilating cause which, if it does occur (and of that we have as yet no proof) must do so at an early period of embryonic life."

It is unnecessary to give a detailed description of all these lesions. Suffice it to say that they consist in order of severity of: Partial epispadias, where the deeper part of the dorsal wall of the urethra is developed; complete epispadias, where the dorsal wall is entirely absent; and subsymphyseal extroversion, where the sphincter at the neck of the bladder is deficient and there is more or less protrusion below the symphysis of the mucous membrane of the posterior wall of the bladder. It is often impossible to say whether one is dealing with a complete epispadias or a slight degree of subsymphyseal extroversion. From the practical point of view the two conditions may be classed together, as they both give rise to incontinence and call for the same treatment. Strictly speaking the second of the two cases here recorded must be regarded as one of complete epispadias with imperfect development of the sphincter, whereas the first case

might be said to have in addition a very slight degree of subsymphyseal extroversion.

The indications for treatment are obviously twofold, namely, to rid the patient of the incontinence and to repair the cleft condition of the anterior part of the vulva. It is the incontinence and not the deformity which causes the patient to seek advice, and it is this condition which has so severely taxed the ingenuity of the surgeon. Time will not permit me to describe in detail the various operative procedures which have previously been adopted. Moreover, the results of these procedures have proved so disappointing that I shall content myself with referring the reader to the admirable papers of Dr. J. W. Ballantyne (1895) and Nove-Josserand and Cotte (1907). The former author, after describing a typical case in an unmarried woman, aged twenty years, who sought advice at his clinic at the Edinburgh Western Dispensary, gives an historical and chronological résumé of all the literature on the subject. He found records of 33 cases, and appends a full bibliography. Nove-Josserand and Cotte, after describing a case in a girl, aged five years and six months, cover much the same ground as Dr. Ballantyne. They found records of 30 cases, and they give an admirable epitome of the operative technique of the 18 cases which were subjected to surgical treatment. In none of these 18 cases were the ureters transplanted. In all except one (in which Mr. Mackins closed the abnormal urethra and substituted for it a suprapubic fistula, with the object of making it easier for the patient to wear an artificial receptacle for the urine), a plastic operation was carried out on the vulva and urethra with the double object of repairing the cleft and at the same time dealing with the urethra in such a way as to endeavor to overcome the incontinence. The former object is not difficult to attain, but as might be anticipated the procedures directed toward curing the incontinence almost invariably failed.

The various methods employed have consisted either simply in narrowing the urethra or in combined narrowing with lengthening. The narrowing was effected either by simple cauteri-

zation, by suturing the raw edges obtained by lateral incisions, by urethral colporrhaphy, or by a plastic operation combined with torsion. A combination of lengthening and narrowing of the urethra was attained in one of three ways: (1) By dissecting down a triangular flap from the mucocutaneous trough above the abnormal meatus so as to restore the superior wall of the urethra; (2) by the formation of two lateral flaps combined with supra-urethral colporrhaphy; (3) by combining lengthening with torsion of the urethra.

As might be anticipated, most of the operators found no difficulty in attaining a satisfactory cosmetic result by restoring the anterior commissure and uniting the two halves of the clitoris above the urethral orifice. In all but three cases, however, the incontinence persisted, and in those in which incontinence was said to have been obtained, it is difficult to gather how far the cure was complete and permanent. As Nove-Josserand remarks: "By lengthening the urethra and restoring the meatus to its normal position a certain amount of curving of the canal is probably produced, and this change of direction of the urethra, which has been both lengthened and narrowed, may be sufficient to bring about a temporary mechanical closure of the bladder. In all the cases reported by us, it is evident that the continence of the urine is obtained by a purely mechanical means of damming back the urine, and that the sphincter is not in any way responsible for it. When the vesical pressure attains a certain degree, the obstacle which has been created to close the urinary reservoir is forced and the urine escapes."

This was precisely what I appreciated before operating on my own cases. It was felt that if the incontinence were to be really cured there was no alternative but to transplant the ureters into the intestine, and this, in spite of the fact that experiments on animals as well as the reported cases in which this procedure had been carried out on the human subject had given very unsatisfactory results, and had been attended with a high mortality.

The fatal results following transplantation of the ureters

into the intestine are due either to immediate or remote complications. Chief among the former is peritonitis, due either to peritoneal contamination at the time of operation or to subsequent leakage of urine or feces, from undue traction of the urethra, or to local sloughing. Of the remote complications the

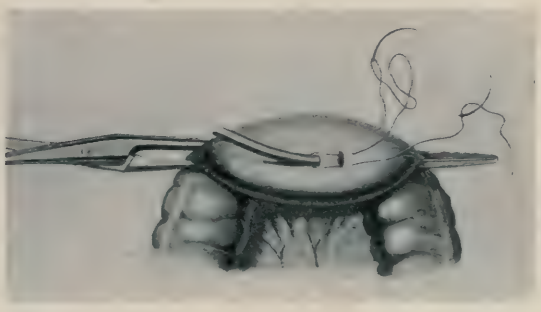


FIG. 3

most important is that which results from an ascending infection of the kidney (either apart from or associated with hydro- or pyonephrosis) the result of cicatrization and stricture at the seat of implantation. In the case of extroversion of the bladder

FIG. 4

most writers are agreed that the best method of preventing an ascending infection of the kidneys is to transplant the ureters along with a portion of the bladder wall surrounding the ureteric orifices. In extroversion of the bladder the trigone and posterior wall of the bladder are exposed upon the anterior abdominal

wall, so that this principle can be comparatively easily carried out either by the procedure of Maydl, or by that first employed by Lendon-Peters. In Maydl's method an elliptical portion of the bladder containing the two ureteric orifices are transplanted into the upper part of the rectum (or the adjacent portion of the pelvic colon) by the intra-peritoneal method. In the Lendon-Peters method, on the other hand, the operation is done extra-peritoneally by freeing the lower portion of each ureter along with a rosette of mucous membrane surrounding the ureteric orifice from the adjacent pelvic cellular tissue and then pulling the extremities of each ureter through a small buttonhole aperture in the anterior wall of the rectum so that the rosette above mentioned lies within the cavity of the rectum. If the rosette is sufficiently large, it is not usually necessary to suture it to the aperture. It is claimed for this procedure that as the operation is done extraperitoneally there is little or no risk of peritoneal infection. In one case of extroversion operated on by the writer, the child died a year after the operation, but whether from kidney complications or not could not be ascertained. In another case death resulted from peritonitis due evidently to sloughing of the end of the ureter and retraction of the stump, and the same unfortunate result occurred in an adult. Although successful results from this operation have from time to time been reported, peritonitis is a complication which cannot always be guarded against, and it has yet to be shown that the procedure is less likely to be followed by an ascending kidney infection than occurs when the divided ureters are transplanted according to the method about to be described.

It is to be noted, however, in epispadias without extroversion of the bladder, that in order to transplant the ureters along with their orifices, the first step in the operation would entail gaining access to these either by opening the bladder suprapubically or by an extensive perineal dissection, either of which procedures would greatly complicate the operation as well as render it a formidable one. It seems to me, therefore, that the best course to adopt in epispadias without extroversion of the bladder is to

expose and divide the ureters as close to the bladder as possible by the intraperitoneal route, and then to transplant them separately into the lower part of the pelvic colon. This brings us back to the vexed question as to how this can best be done so as to guard as far as possible against an ascending kidney infection.

I shall now describe the technique of the operation performed on the two patients above referred to, and as the steps of the operation were the same in both, one description will suffice.

The first case was operated on October 3 and October 24, 1907, the second six months later, namely, April 2 and May 14, 1908. Only one ureter was transplanted at a time, and it will be seen from the dates that from three to six weeks was allowed to elapse before the second ureter was transplanted.

The child being placed in the Trendelenburg position, an incision extending from the level of the umbilicus down almost to the pubic crest was made a little internal and parallel to the outer border of the right rectus muscle. After dividing the skin and anterior layer of the sheath of the rectus, the fibers of the muscle were separated, exposing the deep epigastric vessels which were divided between two ligatures. The abdomen was then opened by dividing the lower part of the posterior layer of the rectal sheath, the fascia transversalis, and the peritoneum. After packing away the coils of the small intestine and the pelvic colon by means of two strips of gauze, one of which was passed toward the left side and the other upward, the ovary and Fallopian tube came into view, the former being situated below and anteriorly at the level of the inner border of the psoas close to the internal abdominal ring. These structures along with the adjacent part of the broad ligament were packed downward and to the right by means of a third swab. The ureter was now very distinctly seen shining through the peritoneum in the form of a yellowish cord crossing the termination of the internal iliac artery, and then passing downward and forward toward the base of the broad ligament, a little below the infundibulopelvic ligament and the ovarian vessels. The peritoneum was now

picked up on either side of the ureter at the level of the brim of the pelvis a little below the termination of the common iliac artery. By making traction upon the forceps a fold of peritoneum running at right angles to the ureter was pulled forward with it into the wound. A small incision was then made at

FIG. 5

right angles to the peritoneal fold along the line of the ureter, care being taken to avoid injury to the small ureteric vessels which were distinctly seen upon the surface of the ureter through the peritoneum. The small opening in the peritoneum was then enlarged with scissors upward and downward along the line of

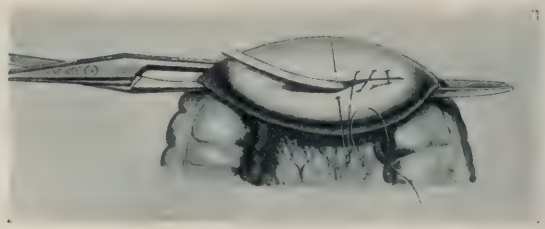


FIG. 6

the ureter. By means of blunt dissection the ureter along with its vessels was now freed from the extraperitoneal cellular tissue upward as far as the brim of the pelvis and downward as far as the base of the broad ligament. In doing this care was taken not to injure the ovarian vessels which ran a little above

and external to it. By means of an aneurysm needle threaded with catgut the ureter was ligatured below the base of the broad ligament a short distance above the bladder. The ureter was then divided a little above the ligature, and after applying sublimated iodoform to the stump, it was allowed to drop back into the pelvic cellular tissue. Before dividing the ureter, however, a light pair of spring forceps was applied to the upper end of the free portion so as to prevent escape of urine during the next step of the operation, namely, the implantation of the divided end into the lowest part of the pelvic colon.

Preparatory to this step, what may be termed a guiding and fixation catgut suture was introduced into the ureter in the following manner: A fine curved needle was threaded on to

FIG. 7

each end of the suture and made to transfix the whole thickness of the wall of the ureter from within outward, about one-quarter of an inch above its divided end, the two needles being made to emerge at a distance from each other equal to about one-third of the circumference of the ureter. In this way a loop was left inside the lumen, the two ends having the needles still attached. The freed portion of the ureter along with the catgut and needles was then folded over the upper edge of the wound and covered with a swab.

Having removed all the swabs, the lowest part of the pelvic colon was now pulled up into the wound and a loop, about three inches in length, was clamped off with a small pair of intestinal clamp forceps. In the young child the longitudinal muscular fibers of this portion of the colon, instead of being

collected into three bands, form a continuous layer around the whole circumference. After again shutting off the peritoneal cavity by placing a fresh set of gauze packs around the loop, a transverse incision, about one-quarter of an inch in length, is made down to, but not through, the mucous membrane on the antimesenteric aspect at the junction of the middle and lower thirds of the clamped-off portion. By snipping off the apex of a tiny diverticulum of mucous membrane, pulled forward by fine conjunctival fixation forceps, a small opening is made into the bowel. The end of the ureter is now drawn through the opening and fixed within the lumen of the bowel by means of the fixation suture. This is done by passing each of the needles into the opening so that they transfix the wall of the intestine from within outward about one-quarter of an inch below the opening, and at the same distance from each other. By drawing on the suture the end of the ureter is pulled toward the small opening in the bowel and gently coaxed through it by means of a probe. After satisfying one's self that the whole circumference of the end of the ureter is well within the bowel, the loop is drawn taut and the two ends knotted on the outer surface of the intestine. Catgut rather than silk should be used for this guiding suture, as it is only intended to serve the purpose of drawing the ureter into the bowel so as to fix it temporarily within the lumen while the more permanent fixation sutures are being introduced. The objection to silk would be that it would probably lead to the deposit of phosphates.

The permanent fixation suture is applied on the Witzel gastrostomy principle. Two parallel folds of the intestinal wall are united over the implanted ureter by means of a straight needle and continuous suture of fine linen thread. The folding-over process should be commenced three-quarters of an inch below the entrance of the ureter into the bowel and should be continued for an inch above it. During the introduction of this latter portion of the suture, the needle, after picking up a seromuscular fold on the one side of the ureter, should, before it traverses the fold on the other side, pick up a portion of the

wall of the ureter without, however, entering its lumen. In the second, and older, child, operated on the diameter of the pelvic colon was considerably larger, and to provide an additional safeguard against leakage, two rows of suture were applied, the first in the same way as above described, except that they were interrupted instead of continuous. Outside these a still finer continuous suture was employed, but without, of course, including the ureter. It is very questionable, however, if this second row was really necessary.

After removing the gauze packs and introducing a fresh set to pack away the ovary and intestines, the divided peritoneum upon the floor and posterior wall of the pelvis was united from below upward by means of a continuous catgut suture, a small opening being left at the uppermost part for the passage of the ureter. In doing this care should be taken not to include the ovarian vessels which lie only a little external to the outer peritoneal edge. In order to diminish the risk of subsequent strangulation either of the bowel or the ureter, it is important to see that the portion of ureter which passes from the opening left in the peritoneum to the site of implantation should be as short as possible, and it is with this object in view that the implantation in the pelvic colon is made as near the rectum as possible.

In the closure of the abdominal wall in young children, after suturing the peritoneum and fascia with a continuous catgut suture, it is not safe to trust to catgut for uniting the recti, as too much strain is liable to be put upon it should any distention supervene, and should the tension be further increased by a fit of crying. In such circumstances the writer has more than once seen a loop of bowel become subcutaneous some days after the operation. This complication is best avoided by the introduction of two or three through-and-through sutures of silkworm-gut, which should not be removed before the twelfth day. In order to prevent these sutures from cutting into the delicate skin, one end should be threaded with a piece of fine drainage tubing, about three-quarters of an inch in length, so that when the

suture is tied, the portion which overlies the skin is surrounded by the tubing. The writer has for many years past been in the habit of employing this little device not only in children but also in adults whenever through-and-through sutures are employed in closing an abdominal wound.

The second operation for transplanting the left ureter in the first case operated on was, as already stated, performed three weeks after the first. On opening the abdomen the peritoneum was found to contain a little clear fluid. The sigmoid flexure presented at the outer part of the wound, while below were the ovary and Fallopian tube lying immediately above the brim of the pelvis, close to the internal abdominal ring. A few slight adhesions were observed between the pelvic colon and the peritoneum forming the left lateral false ligament of the bladder. After separating these with the finger, the pelvic colon, along with the small intestine, was packed away in a direction upward and to the right, while the ovary and Fallopian tube were displaced downward and to the left. The ureter was then freed, ligatured, and divided as low down as possible. The guiding and temporary fixation suture was introduced as before. The gauze packs were then removed, and the ureter was transplanted into the pelvic colon at a point one and a half inches above the site of implantation of the right ureter, and in precisely the same manner. It was satisfactory to note that the parts at the site of the former implantation were perfectly healthy, and more especially that there was no dilatation of the ureter. The pelvic colon, however, appeared to be a little dilated, but its peritoneal surface was normal.

It is unnecessary to describe in detail the steps of the operation in the second case, as, apart from the fact already mentioned that two rows of sutures were employed in folding the wall of intestine over the site of the implanted ureters, they were identical. In transplanting the left ureter in this second case, the only points worthy of note were the following, viz., that there was no trace of fluid in the peritoneum, that the adhesions were still fewer than in the first case, and that the pelvic colon was

rather more distended. As in the first case the parts at the site of implantation of the right ureter were normal. The left ureter was again transplanted about one and a half inches above its fellow.

In exposing and freeing the left ureter, in both cases, by displacing the loop of the pelvic colon well upward and to the right, the ureter could be seen to be crossed by the mesentery of this portion of the colon at the apex of its V-shaped attachment to the posterior wall of the pelvis, that is to say, opposite the intersigmoid fossa. By dividing the ureter close to the base of the broad ligament, and then dissecting it right up into the intersigmoid fossa, a sufficient length of it, namely, two to three inches, could be readily freed so as to enable the anastomosis to be made without difficulty.

The following is a short note of the progress of the two cases after operation:

First Case. Progress after the first operation. Patient gave no anxiety after either operation; indeed, she had a normal and uninterrupted convalescence. There was no rise of temperature whatever, and although for the first three days the pulse kept about 120, it subsequently became normal. Almost from the first urine was passed frequently per rectum, often apart from the motions. There was no abdominal distention, and no trace of tenderness or resistance in the right loin. The progress after the second operation was equally satisfactory. The day following the operation the child was looking well, the temperature was normal, the pulse 120. Almost pure urine was being frequently passed from the rectum. The following day the patient passed a very loose and somewhat greenish motion; pulse, 108; temperature, 97.4° F.; general condition satisfactory.

October 27. Has not cried or complained of any pain since operation; no abdominal distention; urine passed frequently without feces.

October 29. Passed urine every half hour or so during the night, but could retain it during the day, sometimes for four hours.

October 31. Primary union of wound; stitches removed; urination as before; evacuation sometimes almost pure urine mixed, however, with mucus; at other times almost purely fecal.

November 10. Patient always indicates to the nurse when the fecal matter is about to be evacuated, but not always when the evacuation is urinary.

November 15. Eating and sleeping well, and up for the first time (twenty-second day).

November 22. Patient dry for five hours last night and remained for eight hours during the day without an evacuation.

December 4. Only lifted twice during the night. Bladder syringed with boric lotion, which removed a very small amount of mucus.

December 5. Patient discharged quite well, five to six weeks after operation.

Later Progress. A year after the operation the child was admitted into the ward for some days, in order that careful observations might be made of the rectal functions. The mother reports that the child has been very well and happy since operation, and that she now runs about and plays like any other child. She reports that she never wets her clothes during the daytime, but that she occasionally wets the bed during the night. She has no pain when the bowels are moved. She is well nourished and appears to be in robust health. On examining the rectum it is found to be somewhat dilated, but the valves of Houston are distinctly present. Neither kidney can be palpated, nor does deep pressure give rise to any tenderness. The tongue is clean, the appetite good, and the digestion normal.

Second Case. Progress after operation, April 3. As in the first case, primary union was obtained after both operations, and on each occasion the patient made an uninterrupted recovery. After the first operation the pulse reached 136 on the second day, but there was no fever. The urine passed per rectum was slightly blood-stained for the first three days, and during this time there was slight distention of the abdomen.

On April 7 the note of the progress read as follows: Slept well, and is bright and cheerful. No distention; appetite good; pulse and temperature normal. She asks for the bedpan every few hours, and then generally passes urine mixed with a small amount of fecal matter.

April 17. Stitches removed. Firm primary union.

After the second operation on May 14, the pulse during the first few days varied from 120 to 140, but there was no corresponding rise in temperature, and for the first forty-eight hours the urine contained a small amount of blood.

The progress note on the morning of the 16th was as follows: Pulse, 136; temperature, 97.8° F. Patient had a good night; no pain, sickness, or distention.

May 18. Pulse, 118; temperature, 97.6° F. Had a very good night; no pain; takes food with relish, no rigidity or distention of the abdomen. Asks for bedpan about every four hours; no incontinence in the intervals.

May 24. Stitches removed; firm primary union.

May 29. Pulse, 88; temperature normal. Sitting up in bed. Retains urine in the rectum for six hours during the day and often longer during the night.

June 16. Child running about perfectly well. She asks for the bedpan at intervals of from five to eight hours. As a rule, the urine is passed almost free from feces, but generally twice in the twenty-four hours the evacuation is almost entirely fecal.

June 19. Sent to the Convalescent Home.

July 3. Returned from the Convalescent Home; looks and feels perfectly well, has complete continence both day and night, and does not require to be treated differently than any of the other children.

Perhaps no surgical problem has been subjected to so much animal experimentation as that of transplanting the ureters into the intestine, and the results which have been obtained leave much to be desired. The majority of the dogs died either soon after the operation from peritonitis or later on from kidney complications. In many cases these conditions have been

preceded by a hydronephrosis, the result of cicatricial narrowing of the ureteric opening.

In the experiments of Gluck and Zeller (1881) the infiltration of urine along with the sloughing of the stump and peritonitis were no doubt due to the fact that the divided ureter was fixed into the lumen of the rectum by only one suture. Bardenheuer (1886) endeavored to prevent peritonitis by transplanting the ureters extraperitoneally into the ascending and descending colon respectively. Of the three animals that survived the operation, two were killed after four weeks. In each hydronephrosis had resulted from cicatricial narrowing of the orifice. The third, killed a year later, was found to have pyelitis and pyelonephrosis. Ceci and Novaro both had some successes following double intraperitoneal implantation into the rectum, and it is interesting to note that the latter mentioned that he found the anal sphincter hypertrophied in a dog in whom the operation had been done four months previously. Tuffier (1888), Reed and Morestin (1892) did quite a number of experiments, but with uniformly fatal results, death occurring either from peritonitis or infection of the kidneys. Chaput, however, met with more success which he attributes to very careful asepsis and suturing. Connell had comparatively good results by unilateral implantation, but all three bilateral implantations were fatal. Very little better results were obtained by Weller van Hook, Thomson and Wugnoni, Calabin, Frank and Peterson.

As nearly all the animals which survived the above mentioned experiments died ultimately of infection of the kidneys, the operations of the subsequent experimenters were planned with the special endeavor to prevent infection of the kidneys, which, next to peritonitis, is the most frequent cause of death following implantation of the ureters into the intestine. Tuffier (1893) planted the ureters along with their bladder orifice into the rectum, but again the animals died either of general peritonitis or pyonephrosis. Krynski, however, succeeded in preventing ascending infection by imitating Nature's plan of making them traverse the wall of the bowel obliquely. For this purpose he

dissected up a triangular seromuscular flap from the intestinal wall, and, after pushing the ureter through a small incision in the mucous membrane at the lower angle, he sutured back the flap so as to cover over the ureter. Duval and Tesson employed a somewhat similar procedure, but were unable to prevent a subsequent pyelonephritis. Martin was more successful with the following method of oblique implantation. After making a longitudinal incision down to the muscular coat and separating the edges so as to obtain an elliptical wound, he made a small opening into the intestine at the lower angle through which the two ureters were passed and sutured. The muscular coat which formed the floor of the wound was then sutured over the ureters, after which the edges of the serous coat were united. More recently Coffey has performed a series of experiments on dogs which clearly demonstrate the advantage of the oblique or "natural" over the direct method of transplantation. His procedure was very like that of Martin except that he made the ureter traverse the submucous coat for some distance before it entered the bowel.

Matas performed a series of experiments by the Maydl operation, but all the animals died of peritonitis. Of the 21 dogs on whom Peterson performed the same operation, 12 died of peritonitis from sloughing of the bladder flap in consequence of the vesical arteries having been ligatured. Of the remaining 9, four died as the immediate result of the operation, one lived for two months, and the others died subsequently of pyelonephritis. Drucbert employed the same method in a number of animals without a single permanent success. One animal survived for a year, but died of pyelonephritis.

Pozzi and Tizzoni and Connell transplanted the ureters into an isolated portion of the small intestine. The former obtained a few successes, while Connell's two animals both died from peritonitis. Lindner met with more success by transplanting the ureters into the transverse colon. Boari was successful in some cases by using a small button, the diameter of the ureter, the object being to prevent the tendency to stricture, which is

so liable to occur when the divided end of the ureter is sutured to the bowel. The tissue in the grasp of the two halves of the button sloughs and the latter is passed from the tenth to the twelfth day. Of the four animals in which this method was employed, all lived. One of the dogs, which was killed on the fifteenth day, showed only slight dilatation of the pelvis of the kidney, while another, which was killed after thirty-two days showed no abnormality on the transplanted side. It was observed that the ureteric opening in the intestine was quite free. It should be noted, however, that all these four transplantations were unilateral, and it would be interesting to know whether the two remaining dogs ultimately developed an ascending renal infection, as the "free" opening into the intestine, combined with the fact that the ureters were planted directly and not obliquely would seem to predispose to this complication.

Steinke, in the *University of Pennsylvania Medical Bulletin*, June, 1909, gives details of a number of unilateral and bilateral experiments which he performed on dogs, using a variety of methods. He modified the procedure from time to time with the endeavor to prevent the fatal complications which he found to occur. Many of these procedures, however, are not likely to commend themselves as worthy of imitation on the human subject, and it would serve no useful purpose to mention them. Suffice it to say that all the dogs died either of peritonitis or from subsequent kidney complications.

After giving a short review of the literature of the subject, Steinke finds that he was able to collect records of 77 unilateral transplantations in dogs with 51 deaths, a mortality of about 60 per cent. Most of the fatalities were from peritonitis, or a combination of peritonitis and pyelonephritis. Some of the animals that recovered from the immediate effects of the operation died later of pyelonephritis. A number of the surviving dogs were killed later on, and in every instance pyelonephritis or its results were found. Of the 134 bilateral transplantations there were 117 deaths, a mortality of over 87 per cent. Nine of the 17 successful cases showed pyelonephritis later on one

or both sides. The fatalities in most instances were from peritonitis, pyelonephritis, or an association of the two. Other causes of death were hydronephrosis, uremia, and hemorrhage. Most of the dogs did not live long enough to develop stenosis of the ureteral orifices.

Steinke points out that the mortality in dogs is higher because the difficulties of the operation are greater in them than in human beings.

With regard to the history and literature of uretero- and trigono-implantation in the human subject, I may refer the reader to the excellent summaries of Zesas and Steinke. According to Steinke, the first real implantation of the ureters into the colon was performed by Sir Thomas Smith in 1878, in a boy suffering from extroversion of the bladder. The left ureter was planted extraperitoneally into the descending colon. Suppuration and a lumbar fistula resulted, but the latter gradually closed. Fourteen months later the right ureter was transplanted into the ascending colon, fine wire sutures being used in place of catgut. The patient died on the third day, and the autopsy showed that the left kidney was slightly nephrosed and that the remains of the kidney tissue had become transformed into fibrous tissue. The right kidney was enlarged and softened.

Before Maydl introduced his uretero-trigono-intestinal anastomosis, the operation consisted in transplanting one or both of the divided ureters into either the rectum or the pelvic colon, or into the ascending and the descending colon respectively. The operation was done for one or other of the following conditions: Extroversion of the bladder; after removal of the bladder for carcinoma; uretero- and vesico-vaginal fistulæ; and carcinoma of the uterus. In most of the cases the intraperitoneal method was employed, but in the majority of cases of extroversion of the bladder the ureters were transplanted into the rectum by the extraperitoneal method first introduced by Lendon, but often erroneously referred to as the Peters operation. Fowler introduced an important modification of the intraperitoneal method of transplanting the ureters into the anterior

wall of the rectum in such a way that their orifices were guarded by a valvular flap of mucous membrane. "According to a letter from Dr. Fowler to Dr. Peterson, of Chicago, the patient was still alive after three and a half years."

In 1892 Maydl, following Tuffier's suggestion, introduced a new principle into the operation; this consisted in transplanting, not the divided ureters, but an elliptical portion of the trigone of the bladder containing the ureteric orifices into the pelvic colon, the object being to retain the natural sphincteric fibers surrounding their orifices and so to prevent regurgitation of the intestinal contents and consequent infection of the kidneys. This method has the further advantage of preventing stricture and hydronephrosis. According to Zesas, 71 of the 97 cases operated on by Maydl's method recovered. Of the 26, 2 died of shock, 13 of pyelonephritis, 5 of peritonitis, 3 of infiltration of urine, 2 of kinking of the ureters. Ascending infection of the kidneys might be the cause of death up to two years after operation. The sphincteric control over the urine seemed to be satisfactory in most cases.

Berg's method of forming a bladder out of an isolated portion of small intestine, Gersuny's plan of transplanting the ureters along with the trigone into the isolated rectum and then pulling the lower end of the pelvic colon through the pouch of Douglas and bringing it out at the perineum within the sphincter ani; and, lastly, Subbotin's method of making a communication between the ectopic bladder and the rectum and forming a reservoir for the urine out of the mucous membrane of the rectal canal, although ingenious and theoretically attractive, are too complicated as well as too formidable to be selected in preference to the more simple procedures.

After carefully studying the literature on the subject the writer decided to adopt the technique described in the two cases he has recorded, because it appeared to him to be at once a simple and efficient way of avoiding the two great dangers associated with uretero-intestinal anastomosis, namely, peritonitis and infection of the kidneys. The former complication

is best prevented by uniting the ureter to the bowel in such a way as to prevent either urinary or fecal extravasation. These accidents are best prevented by adopting the Witzel gastrostomy principle combined with the picking up of a portion of the wall of the ureter, without, however, traversing its lumen.

While it would be rash to assert that my two patients will remain free from any kidney infection, it is nevertheless very satisfactory to know that more than three years have elapsed without either of them showing the slightest evidence of such a complication. May not this happy result be due not only to the valvular action resulting from the very oblique implantation, but also to the fact that by employing the Witzel principle regurgitation is prevented because the ureter is completely surrounded by the circular fibers of the intestine. As each peristaltic wave passes over the site of implantation, the circular fibers bring about a temporary and active closure of the ureter. It will be observed that in the method I have employed no stitches were put into the divided end of the ureter, and this may perhaps account for the absence of stricture and hydronephrosis.

The favorable result in these two cases seems to the writer to raise a doubt as to the superiority of the Maydl principle of trigono-intestinal implantation over that of oblique implantation of the divided ureter by the Witzel principle. The ureters possess such a rich blood supply that the danger of necrosis is probably no greater with the latter than with the former procedure. The writer's method is probably less likely to be followed by leakage and peritonitis than is Maydl's, and it certainly has a much wider field of application.

Among the more important of these may be mentioned: (1) Epispadias with incontinence. (2) Intractable cases of vesical and ureterovesical fistulæ. In the latter condition the choice lies between nephrectomy and unilateral transplantation. If the ureter be dilated and the kidney diseased, nephrectomy is to be preferred. (3) As a preliminary to complete extirpation of the bladder in cases of carcinoma in which partial cystectomy

is insufficient. (4) In operations for carcinoma of the uterus when the ureter is involved or accidentally divided. (5) In extroversion of the bladder as an alternative to the Maydl and Lendon operation.

Since transplanting the ureters in the two cases of epispadias here recorded, the writer carried out the same procedure in a boy who had a myxosarcoma of the prostate and base of the bladder. The tumor recurred after local removal and ultimately fungated through the suprapubic cystotomy opening. The ureters were transplanted into the pelvic colon at two operations, and three weeks later the whole bladder and prostate were removed extraperitoneally through a suprapubic incision. Unfortunately, owing to the fact that an anesthetic was not administered when the gauze packing was removed five days after the operation, the tension which resulted from the child's crying ruptured the parietal peritoneum and caused an extensive prolapse of the intestines. These were at once replaced and retained in position partly by suturing the abdominal wall and partly by gauze packing. The child, however, died from obstruction due to extensive adhesions.

If the patient's general condition is satisfactory, the surgeon will no doubt prefer to transplant both ureters at the same sitting in order to save the patient the distress of three operations. In cases of epispadias, however, it is no doubt safer to transplant one ureter at a time. In the event of one of the kidneys becoming infected, either temporarily or permanently, its fellow would be able to carry on the renal functions.

It is not, I trust, too much to hope that by adopting this simple method of uretero-intestinal anastomosis as a preliminary step in the treatment of malignant disease of the bladder, the surgeon may be able to deal with cases which up to the present have been looked upon as inoperable. And may I venture to hope that what has been said of the bladder might apply also, though perhaps with less force, to malignant disease of the uterus.

Quite recently Goebell, of Kiel, has introduced a new principle

of treating epispadias in the female, namely, that of utilizing the pyramidal muscles to form a vesical sphincter. By dissecting upward a flap by means of a transversely curved suprapubic incision, these muscles are then freed laterally and at their apices. After separating the recti and freeing the neck of the bladder from the vagina, the pyramidales are turned downward and their apices stitched together in the space between the neck of the bladder and the anterior wall of the vagina. The muscles are also united above the neck of the bladder, and if they are sufficiently well developed they are made to cross one another before they surround the neck of the bladder. By this procedure, Goebell maintains that he converts the pyramidal muscles into a voluntary sphincter. The nerve supply, which is derived from the termination of the last intercostal nerve, enters the muscle laterally at its base and is not, therefore, interfered with. As the result of this operation, the child's condition was so far improved that she occasionally slept the whole night through without wetting the bed, but she was unable to keep herself dry when playing or walking about.

Still another method is that of Hackenbruch, who, after exposing and freeing the anterior surface of the bladder by a suprapubic incision, lengthens its neck by the application of several transverse reefing sutures. Goebell, however, claims that his method is superior, from the fact that he provides the neck of the bladder with a sphincteric apparatus made up of a voluntary muscle.

Steinke sums up the results obtained as follows:

"Of the 35 cases recorded above, 2 have no statement as to whether or not the patient lived after the operation. However, 15 are reported as recovering, and 18 resulted fatally, making a general mortality of about 54.5 per cent. Two cases died of tuberculosis of other organs, thus making the mortality from the operation and its effects 55 per cent. Of the 15 cases reported as living, 2 are unilateral implantations, and unilateral cases are really no test, as there still remains one good kidney to carry on the function. This leaves 15 of the 27 bilateral cases recorded

as living after four weeks or more, making a mortality of 55.5 per cent.

"These results show that under certain conditions the ureters may be transplanted successfully. The ultimate results are, however, uncertain, and fatality is apt to occur under the best circumstances. Experimentation on dogs has proved that it is possible for the kidney to recover from a pyelitis, and this may have occurred in some of the above given cases. However, it has been shown that for routine usage the present methods for simple uretero-intestinal implantation are inadequate, and that the operation is not likely to become a popular one.

"As to which method is most advisable, the following advantages of the extraperitoneal over the intraperitoneal type must be considered:

"1. There is very little if any danger of peritonitis.

"2. A prominent natural papilla has been secured.

"3. The ureters are further protected against infection or sloughing by lying undisturbed in their natural environment almost up to the point of implantation.

"4. The operation is practically free from shock and is easy of performance.

"In view of the generally discouraging results from the records of operations upon the human beings, and from the records of experimental work, we feel that specific conclusions are difficult to draw and would be of doubtful value. We would emphasize again the peculiar nature of the problem, and the fact that so many difficulties must be met in every attempt. A careful consideration of the summary of surgical work upon the anastomosis of the ureters with the intestine leads, we think, to the conclusion that the problem is one of physiological and surgical mechanics, and as such should remain open to solution."

DISCUSSION.

Dr. J. B. Murphy, Chicago.

I was invited to open this discussion, and as the paper covers a rather different field from what I expected in connection with the subject, I feel that I should go over the subject as it appeals to me both in the male and female, and as we have observed it in the management of the lesion in both sexes. Epispadias in the female can be divided from a practical standpoint into three different groups: (1) the upward splitting of the clitoris; (2) that involving the splitting of the urethra back to but not including the sphincter vesicæ; and (3) that including the sphincter and giving incontinence, with exstrophy of the bladder and separation of the pubis and attached recti. In all three groups in early years there is apt to be incontinence, but as the years pass control is gradually obtained first in the standing position and then in the lying position.

First, with regard to the cosmetic effect. Many of these cases have only the deformity without involvement or incontinence of the sphincter. In the male and female the incontinence must be dealt with on the same basis. The splendid plan outlined by the author, Mr. Stiles, seemed in his hands to involve little risk and to give most excellent results, but in less skilful hands it has been followed by a large mortality and many failures.

The first important matter in connection with all cases is to operate upon them, if possible, very early. Why have we not secured better results in the epispadic cases in the female and in the exstrophies of the bladder in both male and female? It is my belief that the failure to get good results in these cases is due not to the fact that the sphincter is not present, for it is there in every case, but because we have not liberated the walls to a sufficient degree laterally, both of the bladder and of the base of the urethra. This is essential in order to get an approximation of the urethra and layers of bladder before we endeavor to produce a union of the edges of both and secure a retention of urine in the bladder itself. There should be a thorough primary freeing of the margin of the bladder and urethra before we attempt to close the bladder. In the type where we have an epispadias in the female, in which the urethra has merely penetrated the clitoris and appears on the under surface of the symphysis, with just a thin web between the urethral lining and the symphysis, an extensive dissection must be made to bring the bladder edges down and expose its neck for approximation if continence is to be attained. (Details of the technique later.)

The contention will be between the two types of operation—one giving splendid results in the hands of Mr. Stiles, as he has reported, and the other that of freeing the muscles of the urethra and bladder sufficiently high to obtain good results, giving satisfaction in a number of cases. A better understanding of this subject can be gained if we analyze the embryology and then classify the factors in each defect. A history of the evolution of the surgery, of the various interpretations of its salient factors in both sexes, and of the former technique, is elucidating and valuable.

Epispadias may be associated with malformations of the bladder and anterior abdominal wall, or it may exist practically alone. The name is best applied to the latter condition. The urethra is seen as an open groove passing upward in the direction of the vestibule, to end either directly in the bladder or in the upper and closed part of the urethra, as the defect may be present only in part of the canal. On each side lies one-half of the split clitoris and attached to each half is the upper end of one labium minus. The labia majora may unite normally in front or may diverge. The bladder is closed in anteriorly and there is usually no separation of the symphysis pubis; it is, however, broader than normal. The bladder cavity is commonly diminished in size. This condition is much rarer in the female, a circumstance which has not yet found a satisfactory explanation (Ballantyne).

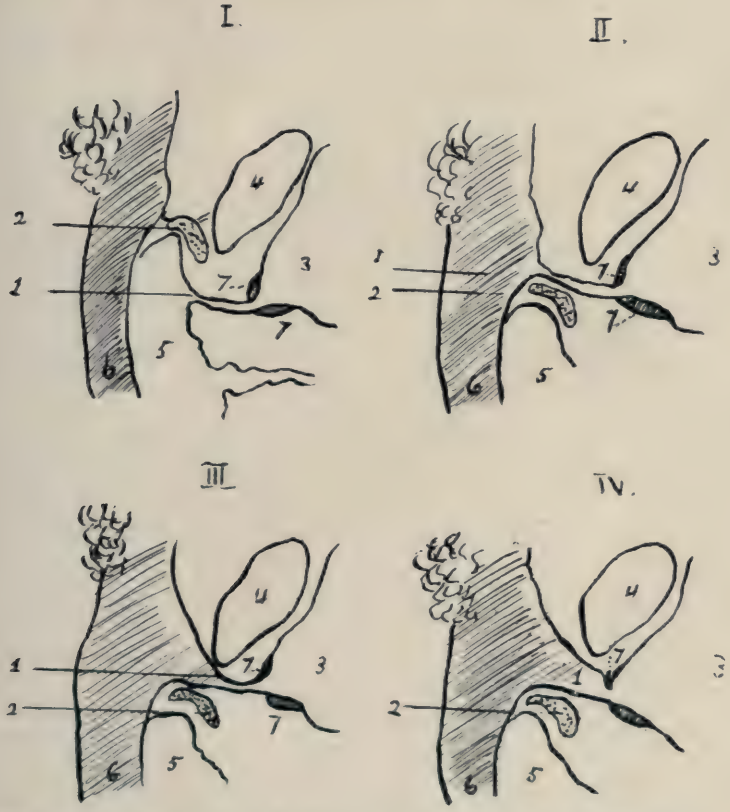
It has only one symptom—more or less complete urinary incontinence—and in the least marked form (clitoridean epispadias) even this may be wanting (ibid). Epispadias is much rarer in the male than hypospadias—about 100 or 150 to 1.

There are, according to Durand, three varieties of this condition:

Clitoridean Epispadias. The first degree of urethral malformation is the simple ectopia of authors. In this type the portion derived from the anal membrane which should form the urethra, in place of remaining localized in the lower half of the genital tubercle traverses it, so to speak, so as to be placed under the pubis, more or less above the clitoris (*II*). The dimensions of the canal remain normal; it has merely strayed above its normal location, and everything else is placed normally. The vaginal orifice, the vulvar vestibule (except the defective meatus), and the clitoris are perfect, only the last tends to approach the anus.

But one case of this type is known, the one reported by Coustou in a woman, aged forty-three years. Nunez believes this case belongs to the ectopias of the urethra, as it does not meet all the requirements of epispadias as defined by Guyon: "Epispadias is a more or less extensive fissured opening of the upper wall of the urethra, with

ectopia of the canal." Durand believes, however, both elements of Guyon are evidently present, especially the ectopia.



SCHEMATIC DIAGRAMS OF EPISPADIAS IN THE FEMALE (DURAND). I. Median section of normal vulva. II. Clitoridean epispadias. III. Subsymphyseal epispadias. IV. Total epispadias.

1, urethra; 2, clitoris; 3, bladder; 4, symphysis pubis; 5, labium minus; 6, labium majus; 7, sphincter of bladder.

The first one may also be demonstrated. If we look at a median section of the vulva (*I*), we can readily conceive the anterior tubercle of the vagina, prolonged as far as the edge of the labia minora, so that the genito-urinary cavity formed by the vulva would be made up of separate genital and urinary conduits. The latter would have the clitoris for its upper wall and the labia minora for its lateral

walls. It might be compared to the penile urethra of the male. If this canal were brought above the clitoris, it would lack the upper wall, the clitoris developing beneath it. Hence the urethra would lack a roof and there would be a true epispadias. For this reason Durand has no hesitation in including this case with epispadias. On account of the homology with balanic or glandular epispadias in the male, he calls this variety "clitoridean," and considers it the least marked stage of epispadias.

Subsymphyseal Epispadias. A case seen by Richelot in a girl, aged six years, shows a stage a little more advanced. The urethra is still above the clitoris, but in place of opening at the base of that organ by a true meatus, so the two portions—subsymphyseal and retrosymphyseal—of the urethra are normally formed, the former (subsymphyseal) of these two halves is malformed (*III*). Its upper wall does not exist and there is merely a gutter leading to a normal retrosymphyseal urethra. Hence there is ectopia and absence of part of the upper wall—epispadias.

Retrosymphyseal or Total Epispadias. Dohrn's case in a girl, aged sixteen years, seems to justify the name of retrosymphyseal. In this case there was a urethra located above the clitoris, which was divided into two halves. The latter appeared on each side at the extremity of the labium minus, hence there was ectopia (*IV*). There was, in addition, absence of the whole upper wall of the urethra. There was nothing left of this wall, for the urinary orifice represented a large infundibulum with a vast opening anteriorly, ending posteriorly after a course of about $1\frac{1}{5}$ inches in a relaxed sphincter. Hence we are authorized to consider this as a case of epispadias. This type has not reached the stage of exstrophy, though just on the borderline. The anterior wall of the bladder is intact, and if examined from within, it is probable the bladder would be found complete.

Auffret's case in a girl, aged nineteen years, appears to belong to this type. This patient had no upper wall to the urethra and the urethral infundibulum led to a much relaxed sphincter, even more so than in Dohrn's case. Nevertheless, the vesical wall was complete, therefore the malformation could not be called an exstrophy.

Such, continues Durand, are the three stages of epispadias in the female. We see that each of them is allied to exstrophy. A step farther, where, in addition to the defect in the upper urethral wall, we have a cleft in the anterior wall of the bladder, no matter how small, and we would have a genuine exstrophy.

He then compares epispadias in both sexes. It is evident, he states, that clitoridean epispadias represents somewhat faithfully a penile epispadias. In both cases, the portion of the urethra which arises

from the allantois is normal, that which comes from the urethral membrane (or its homologue the clitoridean) is malformed and in ectopia above the corpora cavernosa.

But the two other stages of epispadias in the female have no counterpart in the male. They arise at the expense of that portion of the urethra which comes from the cloacal plug, by ectopia, and at the same time an hypertrophy of this latter. A similar malformation has not been found in the male, and would hardly be possible, for it presupposes considerable lesions of the membranous and prostatic portions. In view of the disposition of the parts, it is with difficulty that one can conceive of absence of the roof of the posterior urethra, without there being an accompanying disorganization of the symphysis and the urethral region. The only cases somewhat analogous are those in which there is penile epispadias with increased caliber of the posterior urethra.

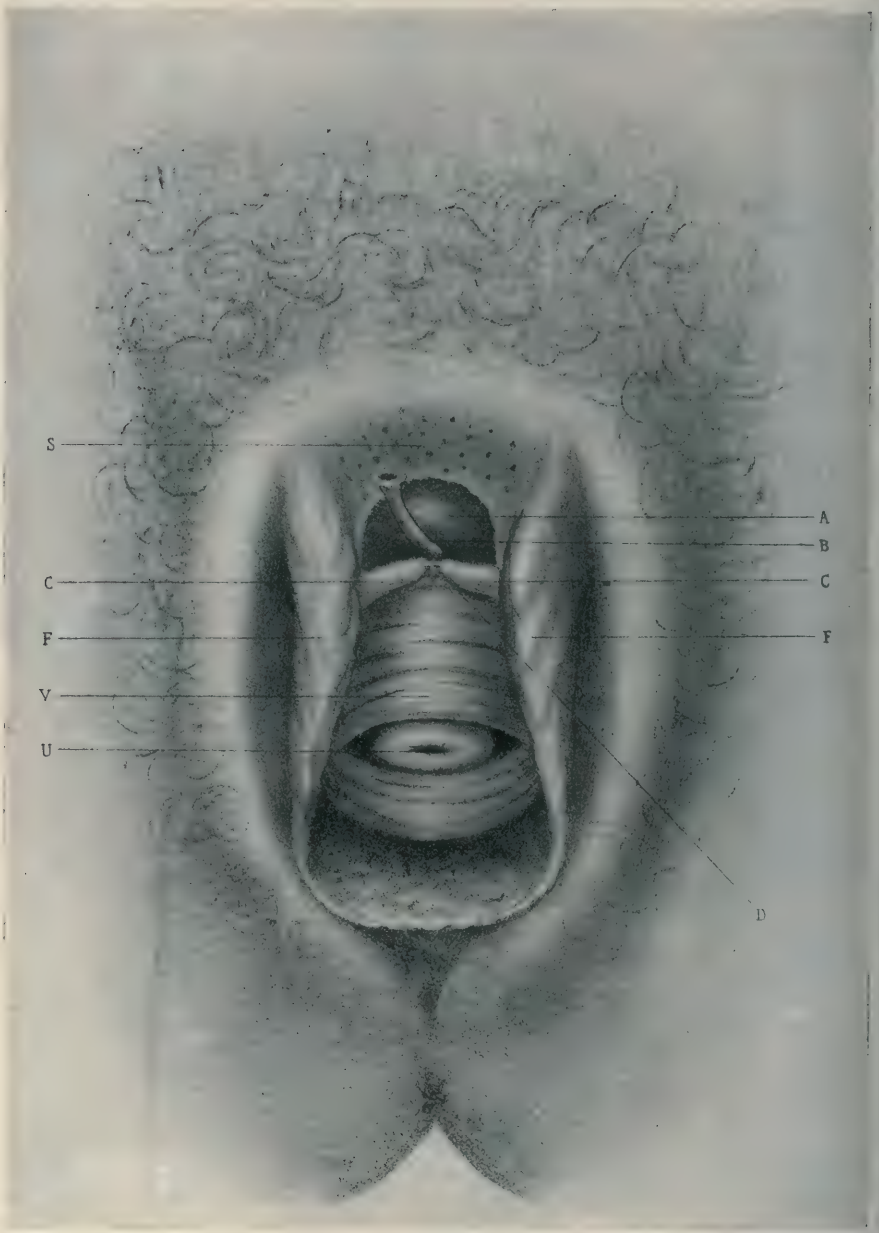
ILLUSTRATIVE CASES.

The first case of true epispadias in the female is that reported by MM. Nunez and Mericamp, from Guyon's service in 1881. The patient was a woman, aged twenty-seven years; incontinence was most marked during the night. When seated she could retain urine about fifteen minutes. One remarkable thing was, the control was best when standing still; in this position urine could be retained for thirty minutes. As soon as she began to move about, however, the urine escaped again.

The vestibular region was considerably modified; neither the urinary tubercle nor the clitoris could be found. In place of the meatus and the vestibule was a good sized orifice, through which protruded a purplish mass; the latter was the mucosa of the bladder, but there was no exstrophy, as it was *below* the pubic symphysis. The pubic arch was normal.

At the upper part of the vulvar opening were two flattened cushions, the base applied against the labium minus on each side, the apex directed toward the vaginal orifice; the ends were connected by a membranous bridge exactly in the median line and $\frac{1}{8}$ by $\frac{1}{25}$ inch. This membrane evidently corresponded to the inferior wall of the retrosymphyseal portion of the urethra; the symphyseal portion proper was absent, while the hiatus through which the mucosa escaped was evidently the urethral opening enlarged by all the vestibular area.

There were in addition several malformations of the external genitals. The labia minora had their usual aspect, but instead



Congenital Epispadias Complicated by Acquired Uterovaginal Prolapse. *A*, hernia of vesical mucosa; *B*, sound introduced into bladder; *C*, *C*, tubercles united by a membranous bridge; *D*, the two tubercles and the membranous bridge pertain to the inferior wall of the urethra; *F*, labia minora; *S*, pubic symphysis; *U*, *V*, uterovaginal prolapse. (Nunez and Mericamp.)

of joining above, they diverged and became connected each with the corresponding labium majus, which also diverged. Moreover, they were longer than usual, and ended not under the symphysis pubis, but on the anterior surface of the symphysis, $\frac{3}{5}$ inch from the median line. In this situation the skin separating them was modified; instead of being thick, covered with hair, underlaid by a thick layer of fatty tissue, it was thin, almost glabrous, and resting on the bony symphysis, with scarcely any tissue interposing. While it would be decidedly uncommon for the clitoris to spring from the inner surface of the labia minora, attempts were made to cause erection of the flattened tubercles on each side; as these were unsuccessful, it was believed this was not erectile tissue.

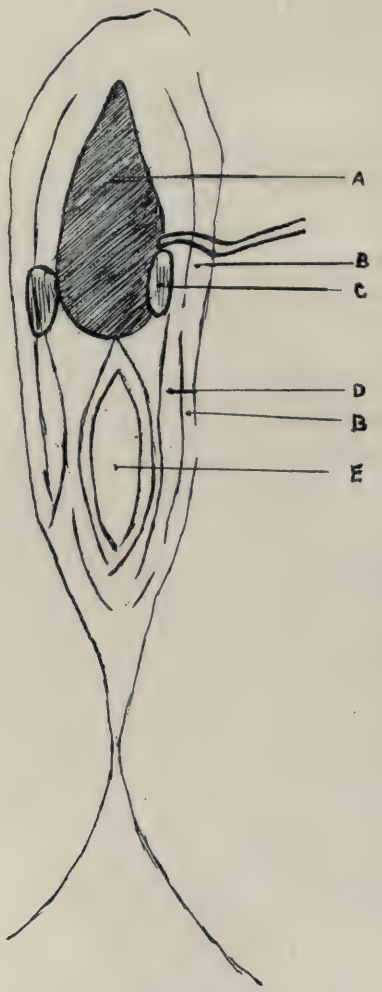
There was a prolapse of the uterus, the patient had given birth to an eight months' child at the age of twenty-three, and the prolapse made its appearance the day after delivery, together with cystocele.

Coustou's case was in a woman, aged forty-three years. The only details are that she was seized with retention of urine. When attempting to catheterize, it was found the urethra opened above the clitoris.

In Richelot's case the labia majora diverged at their upper part. The clitoris was represented by two rosy columns which joined at an angle below the pubis and diverged above like the labia majora; to each of these columns was joined a labium minus. In the space between these parts instead of the vestibule was seen a groove open above, this was the antisymphyseal portion of the urethra, the upper wall being absent. This gutter ended at the middle of the pubic arch by becoming continuous with the retrosymphyseal portion, which appeared normally formed and of the usual caliber, opening into the groove by an orifice placed exactly at the convergence of the columns representing the clitoris. This orifice, closed by the coming together of the mucosa, admitted a bougie as if it were the normal urethra. The bladder seemed to be of some size. Above the canal between the labia majora was a depressed skin surface, corresponding to the symphysis; palpation revealed no separation of the latter. The child was able partially to retain the urine.

Dohrn's patient was a girl, aged sixteen years, with complete incontinence when lying down; when standing, escape only took place every hour or two. Examination showed the mons veneris and labia majora poorly developed. The perineum was large, the labia minora not connected above. The clitoris and its hood were divided for their whole length. Below the halves of the clitoris was a dilated urethral orifice, admitting the finger; the catheter penetrated $1\frac{1}{5}$ inches to the relaxed sphincter vesicæ.

The girl, aged nineteen years, the subject of Auffret's observations, had incontinence in all positions, but this was more marked when lying



KLEINWACHTER'S CASE. *A*, vesical fissure; *B*, *B*, labium majus; *C*, clitoris; *D*, labium minus; *E*, introitus vaginæ.

than when standing, and when walking than when standing still. Hence there was partial retention.

The examination showed there was no urethral tubercle, but instead a small opening extending horizontally. There was no trace of the clitoris, but instead a smooth glabrous surface triangular in shape with the base up, and a large vestibule without any mons veneris.

Inspection of the canal of the urethra showed several interesting details. By slightly depressing the lower lip of the urethral meatus the finger penetrated without difficulty into the bladder after a short course; the bladder seemed normal and of the usual dimensions. The urethral opening being slightly behind the symphysis, as soon as the finger had cleared it the arch was found to be intact, no separation, and was separated from the finger merely by a very thin layer of tissue. There was no procidentia nor escape of the vesical mucosa, hence no exstrophy, the bladder being normal. The author emphasizes the fact that the finger introduced with the pulp toward the pubis detected merely a thin layer instead of the thick wall of the urethra, as is usually the case; however, the bottom and side walls of the urethra were thick, as is normally the case.

As regards the vulva, the labia majora, instead of joining above, diverged markedly, leaving between them a semifunnel-shaped surface without trace of clitoris. The labia minora assumed the shape of floating folds surrounding the urethral opening and vaginal orifice. After the patient had been on her feet for several hours there was uterine prolapse; this could be easily reduced in the dorsal decubitus.

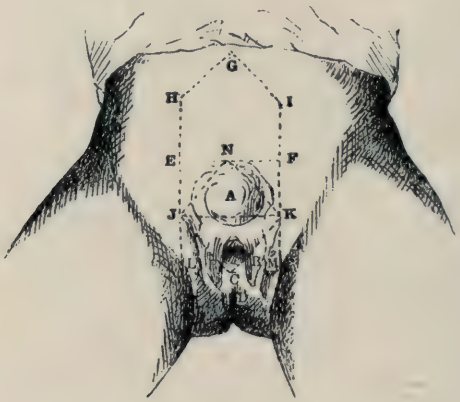
Kleinwachter's case concerned a girl, aged fourteen years. The clitoris was divided into two halves springing from the bottom of a funnel-shaped orifice leading to the bladder. This orifice easily admitted a finger to the bladder, the anterior wall of the latter, very short, ran up behind the pubis. The posterior wall of the usual length was slightly herniated through the orifice in question. Complete incontinence in the horizontal position, less absolute when standing. Patient refused intervention.

Treatment of Epispadias Combined with Exstrophy. The following operation performed by Ayres, of Brooklyn, is recommendable on account of its simple execution and its excellent result. The patient was aged twenty-eight years, and had given birth to a full-term child four months previously, soon after which she had prolapse of the uterus.

A flap of skin was dissected from the anterior wall of the abdomen from above down, following *E*, *H*, *G*, *I*, *F*. This flap was turned on itself so *H* came to *J* and *I* to *K;* a line of dissection was made from *E* to *J* and from *F* to *K*, so as to stitch the edges *E*, *H* and *F*, *I*. The triangle *H*, *G*, *I* thus becomes *J*, *E*, *K*, but instead of that it is

turned up so as to form the figure *J*, *N*, *K*. Hence the bladder is provided with an anterior covering composed of the two thicknesses of the same flap, the raw surfaces facing each other. In this manner a large cavity was formed below to allow the urine to escape, prevent infiltration and allow place for the tumor.

The teguments outside the line *J*, *E*, *H*, *G* and of the line *K*, *F*, *I*, *G* were then dissected and slid over toward the middle line, so the line *J*, *E* became *J*, *N*, and the line *K*, *F* became *K*, *N;* that is to say, the edges of the triangular portion of the flap which was turned up and the lines *E*, *H*, *G* and *F*, *I*, *G* were joined in the middle line. No raw surface was left uncovered. Primary union for most of the wound.

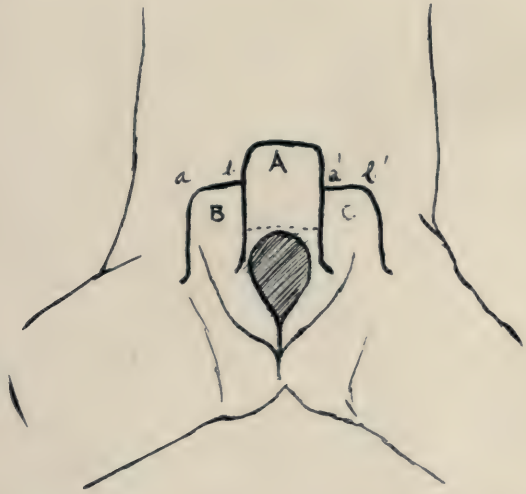


Three weeks later step 2 was carried out. The triangular flap *J*, *N*, *K* was separated from its new attachments and brought down in front of the vulva, as is shown by the dotted line *J*, *C*, *K*. Two incisions, *J*, *L* on the right and *K*, *M* on the left, were then brought to the external angles of the triangle perpendicularly, just to the outer side of the labia minora. The teguments outside of *N*, *J*, *L* (on the right) and *N*, *K*, *M* (left) were dissected up until these two lines could be approximated and joined, following *N*, *C*. This line (*N*, *C*) was thus continuous with the previous scar from *G* to *N*, following the linea alba. In this manner the labia majora could be brought together and cover in the labia minora. During the operation torsion of the vessels was used, together with applications of ice to check the free hemorrhage. After hemostasis was established, the flaps were fastened by interrupted sutures, the lowest ones at *L* and *M* taking in the point of the triangle *C*. Lint soaked in collo-

dion was applied between the stitches and the labia majora by muslin bandages soaked in collodion.

The flaps united marvellously well and cure was complete. Seen a year later, the only thing noticed was a slight prolapse of the anterior vaginal wall after standing for some time; this produced an edematous swelling outside the vulva the size of a chestnut. But owing to the resistance of the retraced vulvar ring, a rubber pessary held the parts up perfectly.

Ashhurst took from the skin below the navel a flap large enough completely to cover the defect (*A*), turned it down, and covered it with two side flaps *B* and *C*, so their upper borders, *a b* and *a′ b′*, met



in the median line. The flaps were united by sutures, and on both sides of the upper one were passed soft iron wire sutures, which were then carried through the bases of the transplanted side flaps, and wound round small rolls of adhesive plaster. Tension did not occur; the flaps healed by first intention; the last suture was removed on the eighth day, and the rest of the wound healed by granulation. Incontinence of urine persisted, however, in the upright position, so that the patient had to wear a urinal; when lying down, however, she could hold her urine for two hours, and her general condition was greatly improved.

Ashhurst, who is no doubt the surgeon who has performed Wood's operation most often, takes care to include in the flaps all the subcutaneous cellular tissue down to the aponeuroses and muscles. He

makes the inguinal flaps as wide as possible at their bases, so as to assure good nourishment. In order to avoid all suppuration or gangrene, threatening primary union, he does not ligate and uses serrefines for the small vessels which are divided. Like Wood, he makes use of figure-of-8 sutures to bring together the upper edges of the lateral flaps slid over to the median line, and like Wood also he avoids transfixing the deep flap.

An important modification introduced by Ashhurst has for its object the fixing of the lateral edges. To this end he transfixes the superficial and deep flaps at two places on each side with a loop of iron wire and twists the ends around a roll of adhesive plaster. This prevents the deep flap from curling up and assures close contact between the raw surfaces.

Greig Smith has also introduced valuable modifications of Wood's method. His first care was to preserve the vitality of the transplanted tissues and avoid the least thrombosis capable of endangering the life of the flap, hence he abstains from touching the bleeding surface of the flap, lifting up the flap from the skin side by forceps and tenacula. For the same reason he does not use compression by sponges and contents himself with irrigating gently with a warm solution of boric acid. The width of the flaps largely exceeds the surface to be covered, so as to preclude all tension or stretching from the urine retained in the reservoir.

In addition to these precautions (which are applicable to all plastic operations), another modification of Smith's, to which he bent all his energies, consists in hermetically sealing the reservoir by suture of its lateral parts. To carry this out, he does not content himself, like Ashhurst, with suturing laterally the abdominal and inguinal flaps between themselves; he goes farther. He begins by freshening the lateral edges of the abdominal flap and the skin surrounding the exstrophied surface; then reversing the abdominal flap on the bladder, he carefully stitches the two freshened surfaces together by fine catgut. This done, he superposes the inguinal flaps to the abdominal flap after the manner of Wood and Ashhurst, suturing the three thicknesses of tissue with silver wire; that is to say, from within out—the perivesical teguments, the abdominal flap, and lastly the inguinal flap. Two or three points suffice for this; the wires are twisted around a piece of soft rubber catheter without stretching or tension, in order to avoid gangrene. The suture of the abdominal wall to the circumference of the bladder has an immense advantage in that it suppresses or at least completely closes the sort of sinus where the flaps come together and prevents infiltration of urine.

In his first operation, Smith united the edges of the inguinal flaps

in the median line by figure-of-8 sutures, but in the second, fearing the stretching and pressure from this type of suture, he used catgut sutures, and in the third operation he replaced the absorbable sutures by horsehair.

The anterior wall of the bladder being reconstituted, Smith covered in the spaces left by taking the flaps, bringing the edges together by figure-of-8 sutures, then he irrigated the new cavity with warm boric acid solution, and covered all surfaces with fine gauze impregnated with boric acid ointment.

Richelot, who has obtained one of the best results reported in France by a modified Wood's method, insists, like other authors, on the necessity of including in the flaps all the subcutaneous cellular tissue down to the aponeuroses. Without occupying himself with closing the sides of the new reservoir, he was very careful about the median suture of the flaps, and also, as will be seen later, the one joining the supravesical flaps to the prepuce. To that end, confident of the guarantee of primary union afforded by complete asepsis, he rejected all complicated methods of suture and only used interrupted sutures of silkworm gut. He did not endeavor to secure union of the surfaces from which the flaps had been taken, merely bringing the corners together by a few stitches and leaving the rest to heal by granulation. After irrigation with a weak solution of carbolic, the surfaces were covered with borated vaseline, over which was a layer of cotton (Pousson).

Treatment of Epispadias Alone. Surgeons have not confined themselves to the male sex in trying to relieve epispadias by plastic operations; some have endeavored to extend this method to the female. Apart from the remarkable operation of Ayres, previously referred to, I am not aware of any other operators save Greig Smith and Richelot.

Both of these conceived the idea of utilizing for the purpose the redundant labia majora, which correspond in the female to the exuberant prepuce in the other sex.

In Greig Smith's case this hypertrophy of all the external genitalia was so great that he was obliged to excise parts of the labia minora as a preliminary. This was attended by profuse, even alarming hemorrhage, which was finally arrested by forcipressure. After hemostasis a supravesical abdominal flap was loosened and two lateral ones; these were then superposed after Wood's method, and they were sutured to the periphery of the bladder opening on the one hand, and to each other along their edges on the other hand, with all the operative minutiæ already described. This part of the operation, as may be seen, presented nothing special. The child was so weakened from the length of the operation and the loss of blood,

that the second stage was not carried out until after the lapse of three months.

"Two incisions of $\frac{1}{4}$ inch were made on each side of the gutter representing the opened urethra, circumscribing the little orifice through which the bladder herniated. The inner edges of these incisions were brought together by a continuous suture of catgut; this was done over a catheter left *in situ* in the rudimentary urethra. The labia majora, which were separated by a small space on each side, were reunited above by three harelip pins and shoemaker's silk. A small urinary fistula ensued in the upper part of the wound, but closed spontaneously in a month's time. As a result there was complete closure of the extroverted bladder with an artificial urethra 1 inch long."

Evidently, adds Pousson, the functional result here was the same as it had always been, that is, absolutely imperfect, though the restoration of the form of parts left little to be desired.

That same year, Richelot, at the Paris Surgical Society, described the technique which he followed in trying to overcome epispadias and exstrophy in a little girl, aged six years. After freshening the inner surface of the labia majora above the vaginal orifice, he brought them together by means of a median suture of three stitches of silkworm gut. By this means he reformed the superior commissure of the vulva, and the tissues of the labia majora, which had been brought together, formed a sort of operculum for the lower portion of the exstrophied bladder. This done, the surgeon proceeded to the reflection of the anterior wall. The thinness of the skin above the bladder did not enable him to make use of the supravesical flap of Wood, so he made two lateral ones. The left flap was turned on to the bladder, the raw surface of the flap being external; the right flap was then slid over so the two raw surfaces were in contact. Interrupted sutures of silkworm gut united these two flaps. To complete the closure of the bladder which remained still open above, the operator loosened a little flap of skin above the opening and joined it to the bladder flap.

The operation was completely successful, and when the patient was shown to the Society there was but a small orifice between the lower edges of the flaps and the restored superior commissure of the labia majora, which had been left purposely to allow escape of urine. Two attempts to close this had failed, but there was no doubt, as the speaker said, that after waiting a little time to enable the tissues to regain all of their vitality, closure would be obtained.

Winckel states that in girls Thiersch's operation may be done more simply and in shorter time than in the male. Although even

when the closure of the bladder is almost complete, continence cannot well be attained, since it is impossible to supply a sphincter, yet slight

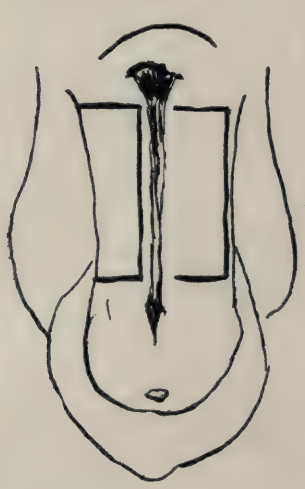
RICHELOT'S OPERATION ON GIRL, AGED SIX YEARS.
State of parts before operation.

Step 1. Reconstitution of superior vulvar commissure by suture of freshened labia majora above the vaginal orifice.

Step 2. Reflection of anterior wall of bladder by plastic operation.

pressure with an instrument will in time cause a certain dilatation of the bladder under urinary pressure. This alone is of great value

to the patient. She can keep herself dry, does not always smell of urine, does not get sore, does not suffer continual pain from the irritation of the mucosa—advantages which would certainly decide most of these patients to submit to an operation which does not in itself involve any danger.



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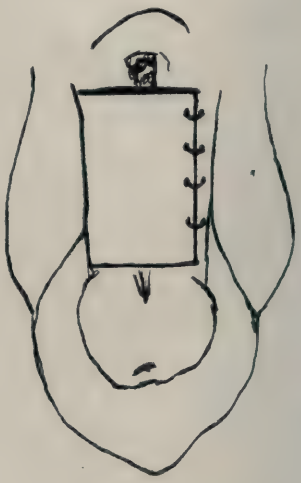

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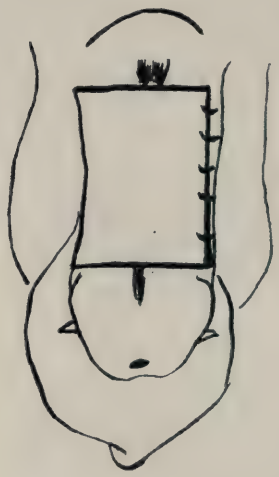

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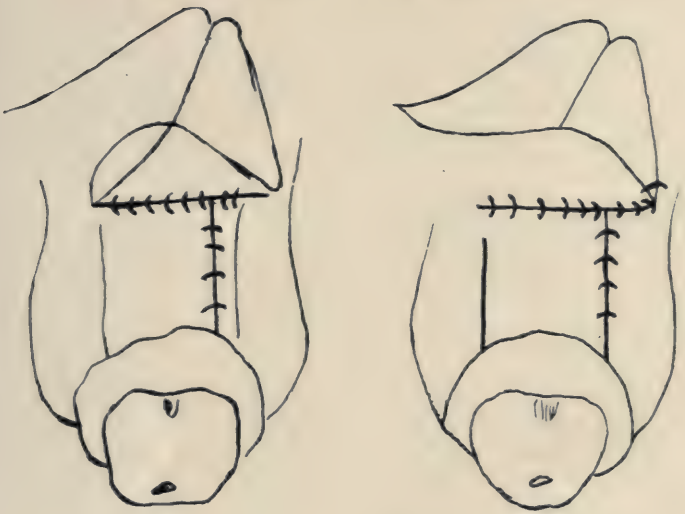


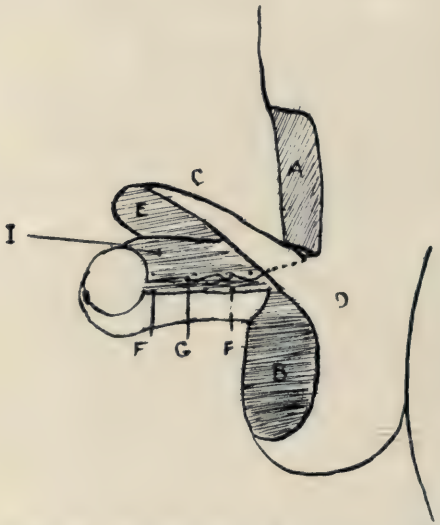
THIERSCH'S OPERATION. *A*, traces for flaps; *B*, the flap on right is slid above the raw surface of the flap on the left fastened on the urethra; *C*, the preputial tissue is incised in its middle; *D*, a triangular flap is loosened and turned on to the funnel-shaped root of the penis. The gland has been passed through the buttonhole in the prepuce; *E*, the rectangular flap seen in *D* has been slid above the first flap applied.

Vogt's attempt (1884) to construct an entire bladder of mucosa by loosening it at its attachment to the anterior abdominal wall, uniting its edges, and then covering it with a flap of skin, was not successful.

Billroth's method is simpler than Thiersch's. He loosens two broad flaps, leaving them attached above and below, and in ten to fourteen days, when the surface is granulating freely, unites them in the middle line. If the flaps are broad enough, no lateral stitches are needed; the side openings close of themselves in five to six weeks. The bladder is thus completely covered, but a small fistula is left at the navel, through which the urine is passed until the urethra is completely closed below. The fistula then closes spontaneously, or is closed by freshening and sutures.

In Frommel's case the whole surface freshened was of the shape of an equilateral triangle, the apex being at the mons veneris, and the sides running down to the lateral halves of the clitoris. From these latter points the line of denudation ran to the borders of the urethral opening. The skin was dissected from the triangle; and to

make the urethra a small needle was passed from below the urethral opening into the wound, and then carried out on the other side of the urethra from the freshened surface to near the edge of the wound. Four such stitches formed a urethra $\frac{1}{2}$ to $\frac{4}{5}$ inch long in addition to the remnants already there. While the stitches were being inserted a silver catheter was left in the urethra. Then the two sides of the triangle were united by superficial and deep sutures. Healing per primam. From the beginning the patient could pass her urine spontaneously, catheterism was not necessary, and she got well (Winckel).



Nélaton's Method of Autoplasty. *A*, point from which abdominal flap is taken; *B*, point from which scrotal flap is taken; *C*, scrotal flap with an opening in the middle through which to pass the penis; *D*, adherent portion of scrotal flap; *E*, anterior border and raw surface of scrotal flap; *F*, freshened edges of skin of penis; *G*, raw edge of abdominal flap; *I*, raw surface of abdominal flap to which the same surface from the scrotal flap is to be applied.

Voillemier recommends Nélaton's operation (modified).

The technique as we have applied it for years, which has given us continence as well as the closure of defect in the great majority of cases, and without a single mortality, is as follows, in the superlative exstrophy cases, and is modified a little to meet the indications in the lesser cases:

1. An incision is made around the vesicle and urethral margins down to the base of the clitoris or penis, cutting through the muco-

cutaneous connective tissue, down to the loose, areolar, subperitoneal, and perivesical fatty tissues.

2. An incision is then made from the highest point of the arc of the first incision, in the direction of the umbilicus, as far as is necessary to expose the normal linea alba, where the two recti begin to approximate each other.

3. Two lateral separations are then made, freeing the peritoneum from the under surfaces of the recti, from the highest point of the second incision down to the attachments of the recti to the pubes. The firm masses of connective tissue at the ends of the symphysis are freed and displaced backward with the urethra and the neck of the bladder, to the attachments of the crura. By this dissection and freeing, the bladder, its neck, and the base of the urethra are entirely freed from their anterior attachments, and can therefore be readily displaced backward, and are also free from lateral traction, the most important factor in securing a permanent union of the approximated edges of the bladder and urethra.

4. The margins of the bladder are then freed from all cicatricial tissue, exposing the muscularis and mucosa. Particular attention must be paid to the freshening and freeing of the margins at the neck of the bladder, the location of the sphincter vesicæ internæ. The urethral base should be well freed, so that it will permit of an entropium of the cut edges of the urethra into the urethral lumen.

5. The freshened edges of the bladder should now be approximated with fine chromicized catgut, by two rows of sutures, beginning at the fundus, the first including the muscularis down to but not involving the mucosa. Great care should be exercised in placing this suture in the sphincteric zone, to secure an infolding and accurate approximation. The stitches should be placed every one-sixteenth of an inch. The second row is placed over the first, in Lembert style, accurately adjusting the muscularis and enfolding the first row of sutures; and if the bladder has been properly freed there should be no special tension on any portion of either of these suture lines.

6. A number five, multiply perforated, soft rubber catheter should be placed in the bladder and fixed to the urethra before the sutures are inserted. This acts as a vesical drain.

7. The recti are then sutured in the middle line, accurately approximating the aponeurosis. When the symphysis is reached it may be necessary to split the aponeurosis near the external inguinal ring, and fold it with half of the detached head of the muscle inward, so as to cover the gap intervening between the ends of the pubes. The periosteum or perichondrium may be carried with this over the middle line. A strip of gutta-percha paper, about one-third of an

inch wide, is placed between this muscular layer and the bladder line of suture, to prevent urinary retention. The lateral skin flaps are then freed out to the inguinal openings and up on the recti, so as to slide easily to the midline, carrying with them all of the fatty structures down to the aponeurosis of the recti.

7. A row of deep sutures should then approximate in the midline the fatty fascial tissues, beginning at the upper angle of the wound and extending well down over the symphysis. This relieves the tension on the second row of horsehair or silkworm-gut sutures placed in the skin. These stitches should be deep, involving at least one-half inch of skin tissue, not tied "too tight," but placed close together. The edge of the wound should then be rubbed with subiodide of bismuth powder, and the whole field covered with boric acid crystals or powder. These dissolve in the urine and keep the field sweet and sterile during the process of repair. The knees should be strapped as in a perineal operation.

The hypospadias is then treated in a subsequent operation with the ordinary plastic technique. It is unnecessary to give the details here.

The freeing of the bladder, and particularly at its neck, is the most important factor in the production of a good result by this procedure. We have obtained perfect continence of urine, not as an occasional but as a fairly regular result, and it can be secured if the details are followed out with precision and technical skill.

The closure of the bony symphysis may be accomplished at a later operation, by an osteoplastic flap from the right or left side. Then one can work in a sterile field, free from urinary contamination and good results can be obtained.

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Dr. Howard Lilienthal, New York City.

I would like to call the attention of the Association to the fact that one more safeguard in these operations can be made use of, and that is one which I think Dr. Ramon Guiteras, of New York, was the first to employ. The plastic work having been done, the sphincter work of which Dr. Murphy has spoken, a small-sized rubber catheter is placed in each of the ureters and is kept there during the time of the healing of the plastic work. In this way the patient is kept dry and the constant flowing of the urine over the operative field is obviated.

Dr. A. T. Bristow, Brooklyn, N. Y.

I would like to state that in cases of exstrophy of the bladder my late colleague and former chief, Dr. George R. Fowler, employed a method of implantation of the ureter exactly similar to that of Mr. Stiles. His procedure was to make an incision through the bowel down to the mucous membrane. He then raised a triangular flap and brought the ureter through into the bowel in an oblique direction, so that the flap acted as a valve.

Dr. Charles H. Mayo, Rochester, Minn.

I have been very much interested in this report by Mr. Stiles. Several times I have had to remove the bladder in the adult for malignancy. I have brought the ureters out into the back in two cases, and it seems to me that this method opens up a wide field for surgery of cancer of the prostate and of the base of the bladder involving the trigonum. I have a case in mind now in which it would be advisable to do this operation which is suggested by Mr. Stiles. Up to the present time we have done a number of transperitoneal removals of malignant tumors of the base of the bladder. By such procedure we can prolong life and give relief from hemorrhage, but there will be a continuation of the growth in the future because it is only imperfectly removed.

It seems to me that the operation of Mr. Stiles can be applied to a great many people suffering from cancer of the bladder and prostate at the base, doing this radical procedure as an early rather than as a late operation.

Dr. Arthur Dean Bevan, Chicago.

I should like to submit a question in connection with this work. Would it not be possible in developing this field to make the transplantation of the ureters into the last part of the ileum just above the ileocecal valve, where the contents of the intestine are fluid, where

it contains few pathogenic germs, where it would be protected to a certain extent by the action of the ileocecal valve from the great danger of ascending infection?

Dr. Arpad G. Gerster, New York City.

The suggestion of Dr. Bevan of making the transplantation of the ureters into the last part of the ileum, seems to be very plausible; but there is one danger about it, and that is the absorption of the urine resulting in uremia, as has been observed both in animals and in human beings. As regards the method proposed by Mr. Stiles, I would suggest in the technique that as we know the physiological penetration, the anatomical penetration of the ureter through the bladder wall is an oblique one, it would be perhaps better to imitate that as far as possible, so as to get the valvular action, and that could be done in this way, according to Coffey: Incise the intestine going down, just as Mr. Stiles proposed, to the mucous membrane, but make the incision longer than his, extending for an inch or an inch and a half, then at the lower end of this incision make a stab through the mucous membrane, passing the proximal end of the ureter through this, and tacking it to the inside of the gut by means of two needles previously attached to the cut end of the ureter. These sutures should embrace the entire thickness of the gut. Then, leaving the mucous membrane intact for the whole length of this wound, infold the outer layers by two tiers of Lembert sutures. Thus, you will have a long and I dare say a more natural canal than that produced by the Witzel method. The mucous membrane would be in immediate contact with the ureter, and the compression of the gases and feces would thus act to close up the ureteral orifice and prevent the ascension of infectious material toward the kidneys.

Dr. James E. Thompson, Galveston, Texas.

The question as to the value of this procedure must, I think, remain for quite a little time *sub judice*. I do not think a sufficient length of time has elapsed since Mr. Stiles operated for us to say that an infection will not pass up the ureters to the kidneys. I speak from personal experience of two cases.

One of my own, reported in 1904, where I had transplanted by a modification of Maydl's method both ureters into the pelvic colon, and where my patient did splendidly for three and one-half years, and was in good health, with no evidences of ascending infection, and then suddenly fell sick, and in three or four months died, a post mortem showing both kidneys riddled with abscesses.

The second case was one which I saw in the practice of another

physician. The patient lived for almost four and one-half years, apparently in splendid condition, then suddenly sickened. When I was called to see the patient there were swellings in each lumbar region, pus in the urine, and he was almost in a comatose state from uremia.

I mention these cases to show that I do not think we can say that we can safely transplant the ureters into the intestines under any circumstances.

Mr. Harold J. Stiles. I was very much interested in what Dr. Murphy had to say—he always illuminates any subject he discusses—and I think perhaps in my next case I may begin by attacking the condition from below, although I went very carefully into the literature of this mode of attack, and the results were very unsatisfactory; possibly, however, the procedures were not carried out with the same thoroughness that Dr. Murphy would have practised. I shall look forward to hearing the result of his method should he have occasion to try it.

With regard to Dr. Mayo's remarks, I was glad to hear him. Although I have had little experience of malignant disease of the bladder in comparison to him, I also feel it would be well to adopt the procedure outlined in my paper in these cases, for I think it is better to let the patient run the risk of dying of kidney infection rather than to go on suffering.

Dr. Bevan's suggestion is an interesting one, and I have referred to it in my paper. It has been tried, but the results have been unsatisfactory.

In regard to Dr. Gerster's suggestion, I thought of that, and if I remember rightly it was the plan Dr. Coffey used on dogs. It seems to me, however, that the Witzel method gives just as great obliquity of transplantation and provides for circular muscular fibers all around the ureter. I do not think there is any advantage in planting the ureter in the submucous tissue.

I quite endorse what Dr. Thompson says. I do not propose to say that these patients are permanently cured, but I think they have a better chance than older people.

THE OPEN TREATMENT OF TRANSVERSE FRACTURE OF THE FEMORAL SHAFT.

By EDWARD MARTIN, M.D.,
PHILADELPHIA.

THE subject matter of this paper is confined to a consideration of the open treatment of the more or less transverse fractures of the femoral shaft. A detailed study of a type lesion gives greater opportunity for that discussion and criticism on the part of the clinically experienced and manually skilled which each member of a society such as this both welcomes and dreads.

The indications for open operation in the case of these transverse or nearly transverse femoral fractures are afforded by failure to accomplish adequate reduction either with or without the negative help of a general anesthetic; failure to retain the fragments in proper position, even though they be so placed; and wound of the soft parts leading to the seat of the break.

As to what constitutes adequate reduction, the broken ends should be in at least partial apposition, there should be no obvious angling at the seat of the break, and the shortening should not be greater than a quarter of an inch. A complete and irremediable overlapping, even though it be slight, should be regarded as an indication for operative intervention, provided the patient's general health be fairly good.

Neither the accuracy of reduction nor its persistence under the retention dressing can be assured except by means of the *x*-rays. Nor when it can possibly be avoided should the responsibility of treating these cases be taken without the help afforded by the shadow pictures.

The prognosis of transverse fractures of the shaft of the femur is fairly good even under conservative treatment. Complete overlapping by no means insures non-union, nor do marked

shortening and angulation necessarily cripple in proportion to their degree. The functional prognosis bears quite as definite a relation to the age of the patient as it does to ultimate deformity, the outlook being almost uniformly good in children, more or less bad in those past middle age.

Taking into consideration all the femoral fractures, the prognosis even as to immediate survival is by no means assured, the mortality being under conservative treatment about 10 per cent.

The time for surgical intervention is as soon after the injury as the surgeon is reasonably assured that he can either not reduce the fragment, or having reduced it cannot retain it in place. We have not been successful in accomplishing by persistent use of weights and splints a reduction which could not be secured by direct manipulation.

By an immediate operation blood clots are evacuated, and the fragments are brought into their proper relation to each other more readily than at any other time. The lesser hemorrhage and the greater resistance to infection developed in four or five days from the time of injury are advantages which should receive careful consideration. The longer the deformity persists the more difficult is its reduction.

The operation is performed for the purpose of accurately apposing the broken bone ends and of securely holding them in this position until they have grown together. These purposes are best attained by means of the buried metal plate secured in place by screws. In an experimental work with dogs, intramedullary bone and silver cylinders have not given even a promise of either greater ease in application or more assurance of favorable results.

Since the plates when fixed are subject to bending and twisting strain incident to the contraction of powerful muscles and the weight of the part, they must be strong and must be so firmly secured to the bone that they will not tear loose. The entire success of the operation depends upon the strength and the fixation of the plate.

The bone plates commonly used, called the Lane plates, are made of fine-grained, cold-rolled blue steel, and because of the expense incident to another method are stamped out. They

are provided, at least in so far as those adapted for use in the femoral shaft are concerned, with from four to eight countersunk and slightly reinforced screw holes, arranged in series of two, three, or four at each end, with a strong solid band between. The steel screws are threaded to their heads, are machine made, and are of such length that when driven home they reach to the medulla, passing through one cortical thickness, or entirely across the bone penetrating the cortex on each side.

Before using such a plate the surgeon must be assured that it will neither be broken nor bent by any force to which it is likely to be subject. Because of an eight-screw plate having broken in the thigh of a fat, muscular woman, incident to a shift in her position, some cadaveric observations were made having for their end the rough determination of the uniformity and strength of the plates usually supplied. These observations showed a marked variation and demonstrated that some of the plates break from slight force, usually at one of the screw holes nearest the fracture, the blue plates bending before breaking.

As to the holding power of the screws, it was shown that two on either end of the plate are sufficient, the plate breaking before the screws pull out. It was further shown that the short screw passing through but one thickness of the cortex holds beyond the breaking strain of the plate. Experiments on dogs and observations on the human demonstrated that when the wound remains clean the screws continue to hold for days, weeks, or years, and when removed have to be unscrewed exactly as though they had been driven into hard wood. To this rule there are certainly exceptions—as evidenced by an *x*-ray picture of a fractured femur taken more than a year after the original injury and the operation. Though recovery was complete and function fully restored, the screws are shown clumped at one end of the plate.

It is obvious from the observations detailed that plates should be strengthened at the point of usual breaking, *i. e.*, the screw hole nearest the fracture, that they should be made of the strongest possible material, and that they should be tested before they are sold, and guaranteed to this test by the instrument maker. Such a plate, reinforced at the screw holes, is

made by Lentz, of vanadium H grade steel from the Carnegie Steel Company, and is of course more expensive than the stamped implement usually to be found in the shops.

Given a sufficient area of bone to hold the screw, the nearer the latter to the line of break the less the leverage. If, however, the screw be placed nearer than a quarter of an inch, a cross-strain will probably break it out. Though the screws are machine made, they vary slightly in pitch and diameter. Since it is important that they should be driven home easily, there should be a sufficient number to select from in case one or more are not readily turned in.

Strong plates and screws of proper length having been selected, the means of promptly securing the former to the bone must be provided. This implies a clamp or forceps, for holding the plate in position after the bone ends have been brought in proper relation to each other, a bone drill of such size that it bores a hole a trifle larger than the core of the screw (a thirty-two Standard twist drill is the one usually employed), and a screw-driver which holds the screw until it is driven nearly home in its bed. Tapping the drill hole would be serviceable except for the individual variation in the machine-made screws. Lohman's clamp is the most generally serviceable, though its projecting handle sometimes makes drilling difficult. My own smaller clamps are often useful; the cross-bar originally devised has long since been discarded. These forceps, the Lentz modification of the Lambotte instrument, at times serve when other tools will not, both for accomplishing complete reduction and holding the plate in place while it is being fastened there by screws.

The screwdrivers shown are one of my own devising and a better and simpler one used by carpenters and slightly modified by the instrument makers.

In addition to the screws and plates and the tools for their proper fixation, means must be provided for the reduction of the fracture after it is reached by incision.

The less the bone is stripped of its periosteum or the periosteum of its investing soft parts the more prompt and assured the union. Hence the use of levers is not advisable unless

reduction cannot be accomplished in a simpler way. In recent cases a non-traumatizing reduction is greatly facilitated by combined lateral and longitudinal traction. Lateral traction, usually postero-anterior, since the lower fragment commonly lies behind the upper, is best applied by a strong tape passed around the lower fragment by means of a curved blunt needle, the tape being threaded on a silk loop carried in the eye of the needle. Longitudinal traction is applied by a sheet clove-hitched about the ankle. Since the effect of this longitudinal pull may be to accentuate the backward displacement of the lower fragment because of the transmission of the force through the excentrically placed lateral ligaments of the knee-joint, the fascia lata, and the fibrous septa attached to the inner and outer lips of the linea aspera, it may be impossible to accomplish reduction by this method. If this be the case, traction with a flexed knee may serve. If this fail, both bones may be angled out over the arm of a strong assistant; the broken ends are then apposed outside the wound, and the femur is straightened, a powerful leverage being thus afforded in overcoming the resistance afforded by the pull of the contracted muscles and fibrous tissues. This method of reduction involves far less traumatism and interference with periosteal and bone blood supply than digging and prying out the broken ends by means of powerful levers. Final close apposition and accurate alignment is at times only secured by strong forceps pressure; Lane's long-handled bone forceps are applicable in many instances; the ordinary nickel-plated plumber's forceps are cheaper and more powerful; the Lentz modification of the Lambotte forceps is occasionally invaluable not only in accomplishing the complete reduction which may be resisted by small bone spicules, but in holding the plate in position while holes are drilled and the screws are driven home.

In fractures not operated upon at once or within a few days after injury the major difficulty will be experienced in overcoming shortening. Nor will any force applied to the ankle or leg necessarily accomplish reduction. This shortening can be overcome only by powerful traction applied directly to the upper end of the lower fragment.

A canvas band sufficiently strong to stand a pull of two hundred pounds is the most efficient and least traumatizing means of exerting this direct pull. The middle of the band is passed over the end of the bone, the two ends are carried down as nearly as may be parallel to the long axis of the leg, and into the loop with which each is provided is passed a rope which in turn may be attached to weights or to a block and tackle. The bone is prevented from angling out by direct pressure through gauze pads, and if weights be used, three to ten minutes may be needful before the desired amount of stretching is accomplished. The traction is continued until there is an actual lengthening of at least a quarter of an inch. It will then be found that apposition is not difficult.

A weight of one hundred pounds is usually sufficient, delivering as it does over the wheel something over ninety pounds of pull. In long standing cases we have found double this amount of force needful, and have been compelled to reinforce it by hand traction.

Under some circumstances it is obvious that the amount of stretching required to overcome shortening is beyond the limits of safety, and sectioning of the bone ends is then required.

Having provided the instruments and appliances necessary for both reduction and the easy plating of the fracture, the question of subsequent retention and protection against cross or twisting strain must be considered. The best retentive apparatus is a reinforced plaster-of-Paris bandage carried from the foot to the eighth rib and cut at the sides while still soft so that the upper portion can be lifted away as a shell. This enables the surgeon to maintain even pressure by changing the padding as required, and allows of early massage and passive movement. In extremely fat people the application of such a dressing is difficult and its efficiency questionable. We have, however, nothing better to suggest. In one such patient the effort was made to remove strain by suspending the leg and thigh in a wire splint. The result was disappointing. The plate first bent and then broke.

Concerning the operation itself, the break is best approached with the least injury to important structures by an incision

carried along the outer border of the rectus muscle and through the crureus. A break in surgical technique is perhaps more surely punished in this operation than in any other. Covering the skin through which the incision is made by gauze sheets clipped to the edges of the cut is distinctly desirable. The avoidance of putting the fingers in the wound is of vital importance. Even in ordinary operations 60 per cent. of the gloves are torn or punctured. The forceful manipulations sometimes needful in reducing and plating fractures usually tear even the heavy gloves which we always use when operating on bone. Indeed, Lane's technique seems entirely rational.

As to the results of the operation, union is nearly always delayed, the delay being proportionate to the amount of stripping of the bone ends and trauma of the soft parts at the time of operation.

We have had some cases of suppuration of slow almost afebrile type not becoming manifest for three or four weeks from the time of operation. In two instances cultures showed the infecting organism to be the Staphylococcus albus. In one of these and in one not cultured the infection was entirely confined to the soft parts and had no connection with the plate or the seat of fracture, healing slowly under drainage. In a third instance a suppuration of the same type had burrowed beneath the rectus muscle and formed an abscess on the inner side of the leg. Several months after operation the plate was removed. The bone was perfectly healthy, the upper screws tight, and the evidence was to the effect that a mild infection had passed from without in. The albus was in this case the infecting organism.

We have no evidence that the period of after-treatment before complete, or what we call complete, restoration of function is accomplished, is materially shortened by plating. Nor can we assert positively that a plate healing in place without infection will remain for life without giving trouble, though there is reason to believe that it will, and cases show that it has so done for periods of from four to twenty years.

Our ultimate results in cases of transverse fracture of the shaft of the femur have been very much better under plating than could possibly have been obtained by any other method. We

have no hesitation in advising the operation when the conditions already indicated in this paper are present, *i. e.*, a fair degree of health and vitality and a complete overlapping. We expect a primary healing, but a long convalescence.

We are by no means enthusiastic advocates of the open method either here or in the other long bones, when satisfactory apposition can be secured by other means. Indeed, we feel that if all the results of the present wave of enthusiasm could be collated, they would not reflect credit upon either the method itself or upon the surgeons applying it. It also seems clear that the operation for its successful outcome is almost as largely dependent upon proper tools as is that, for instance, of litholapaxy. Given a scrupulous surgical cleanliness, and a natural gentleness in handling tissue, the question of result is as much dependent upon the wise choice of instruments and plates as it is upon the manual dexterity of the surgeon.

[For Discussion, see pages 78 to 93.]

THE TREATMENT OF OBLIQUE FRACTURES OF THE TIBIA AND OTHER BONES BY MEANS OF EXTERNAL CLAMPS INSERTED THROUGH SMALL OPENINGS IN THE SKIN.

By LEONARD FREEMAN, M.D.,
DENVER, COLORADO.

Many unsatisfactory results are obtained in oblique fractures of the tibia. As soon as the injured muscles regain their contractility the fragments frequently begin to slide by each other with exasperating persistency, in spite of the most ingenious splints; and all efforts to prevent shortening and deformity are too often futile after secondary contractures of the tissues occur. Even when the functional result is sufficiently good, the surgeon is still in legal danger, as I have seen in several instances, because a radiograph can show such poor coaptation that a suit for damages may be instigated.

The methods usually employed in the treatment of these oblique fractures are:

1. Splints or Plaster Casts. These are often powerless to hold the fragments in place without undue tightness or injurious and painful pressure upon the bony prominences of knee or ankle.

2. Extension. In this situation extension is difficult to apply in sufficient amount without discomfort to the patient. Even sloughing of the skin, injurious stretching of the ligaments of the knee, or damage to the nerves or vessels may result, to say nothing of the irksomeness of having to lie continuously in one position for several weeks.[1]

[1] Steinmann has recently applied his "nail-extension" to this form of fracture, which is, perhaps, an improvement over older procedures, although inferior, I believe, to the method to be described.

3. Open Operation. The difficulty can undoubtedly be remedied in this way, but at the expense of some risk. Such procedures usually mean a large wound, together with considerable manipulation of the tissues and stripping up of the periosteum. Hemorrhage is at times hard to control, and fragments may have to be removed which could otherwise be left in place.

The chance of infection is perhaps not great, with a competent surgeon and favorable surroundings; but in the hands of inexperienced operators, under whose care fractures most often fall, the danger is considerable.

The tibia is one of the most frequent sites of delayed or non-union, and particularly is this true of fractures which have been operated upon and perhaps united by wires or bone plates. Fritz König asserts that this is due to the removal of blood clots and tissue fragments, which are supposed to stimulate bony union, while others place the blame upon the foreign bodies introduced by the surgeon; but whatever the explanation may be, the fact remains.

In addition, even if there were no real objections to an extensive open operation, there would still remain many patients who would refuse to have it done, and numbers of physicians whose experience and prejudices would not permit them to do it.

Hence it is desirable that there should be some easy and effective method of handling these oblique tibial fractures which is not open to the criticisms mentioned above. With this idea in view, it occurred to me that all the requirements could be met, in many instances, by inserting a screw with a long projecting end, through a small hole in the skin, into the upper fragment, well above the fracture, and another into the lower fragment, then reducing the fracture by manual extension and fastening the screws together by a firm external clamp (Fig. 1 and Fig. 2, *a*, *b*). After testing the method, I made brief mention of it in a discussion on the operative treatment of fractures in the Surgical Section of the American Medical Association, June, 1909.

Operative Technique. The shape of the fragments and their relation to each other is determined by manipulation and

especially by the use of the *x*-rays. Under general anesthesia two small incisions, each about one-fourth of an inch in length, are made through the skin and fascia over the flat anterior

FIG. 1

surface of the tibia, one below and one above the fracture. They should be situated well away from the break—if possible, in sound, unlacerated tissue.

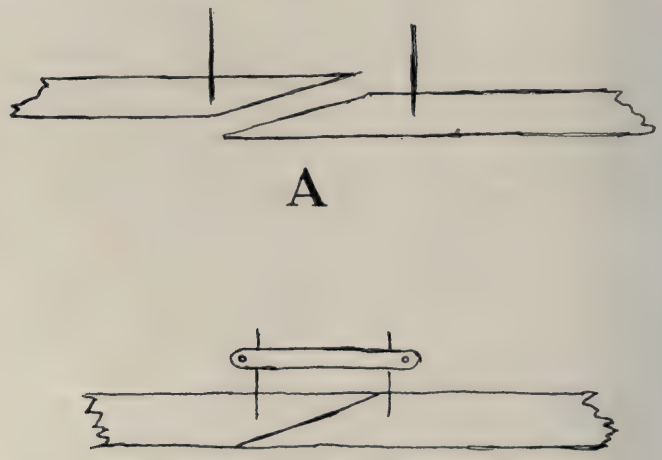

FIG. 2

Through these incisions holes must now be bored in the bone for the reception of the screws. This, of course, can easily be done with ordinary drills; but unless some special apparatus is employed, such as I shall describe, the soft parts will close over

the opening in the bone as soon as the drill is removed, thus preventing the insertion of the screw. Every surgeon who has done much bone-work has doubtless been annoyed by similar occurrences. To prevent this I employ a small steel tube (Fig. 3, *a*), about the size of a lead pencil, having several sharp teeth at one end, which may be driven into the bone by a tap with some heavy instrument. An obturator (Fig. 3, *b*) guards the teeth and facilitates the forcing of the tube through the tissues by means of its pointed extremity.

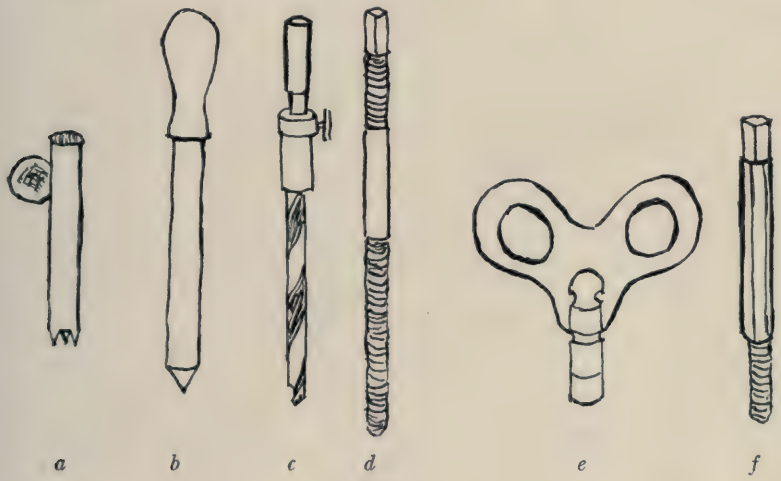

FIG. 3

When the tube is set firmly against the bone an assistant holds it in place by grasping with a pair of forceps the lateral projection provided for the purpose. The obturator is then removed, and a drill inserted in its place, which is fashioned with an adjustable shoulder to fit the tube (Fig. 3, *c*), in order to centralize the hole in the bone and facilitate the entrance of the screw.

The hole must be deep enough to permit the screw to hold firmly, and its lower extremity should be slightly inclined away from the fracture in order to give a secure purchase to the clamp against the contraction of the tissues. It should extend through the cortex, at least, and sometimes even through the medullary

cavity into the cortex of the opposite side, especially when the osseous structure is unusually soft.

When the drill is removed, a screw which fits the tube (Fig. 3, *d*) is easily inserted and the tube withdrawn. The screw should be long enough to project some two inches above the skin after it is driven home. *It must be slightly larger than the drill-hole* to insure solidity, and somewhat pointed at its extremity so as to enter easily. Its outer end is squared to fit an ordinary clock key (Fig. 3, *e*), by means of which it is manipulated. The threads are continued up to this squared extremity, thus giving a better grip to the clamp.

The question might here be raised, why the drills could not be left in place, instead of taking the trouble to remove them and insert screws? But this is not practicable, because the drills are smooth and smaller than the holes, and hence would be lacking in firmness. Practically the same thing can be said of nails, which, in addition, as they are driven into the fragments, may split them and ruin the chances of success.

Forcible manual extension is now applied to the leg until the fragments are brought into position, when the projecting screws are clamped together (Fig. 2, *a* and *b*), thus preventing recurrence of the deformity. The clamp used for this purpose is made of two long, firm strips of steel, held together at their ends by screws, which can be tightened and loosened with a clock key (Fig. 3, *e*). A most important feature is that these metal side pieces are lined with soft pine wood, into which the threads of the screws bite as firmly as if the screws were driven through a solid block, thus preventing the possibility of their easily working loose (Fig. 4, *a* and *b*). A dressing is now applied, using thick pads of sterile gauze around the clamp, and the leg is securely, but not too tightly, splinted.

It will, of course, be understood that the sole object of the clamp is to prevent the ends of the bones from sliding past each other, which is the main difficulty in oblique fractures, and the one hardest to overcome. Angular deformity and lateral separation of the fragments must be controlled by splints, which should be carefully adjusted to the sides of the limb as well as posteriorly.

The use of splints could undoubtedly be rendered less necessary by placing two screws in line in each fragment, as is done in open operations with external clamps, but I am convinced that this is usually unnecessary and merely complicates the procedure.[1]

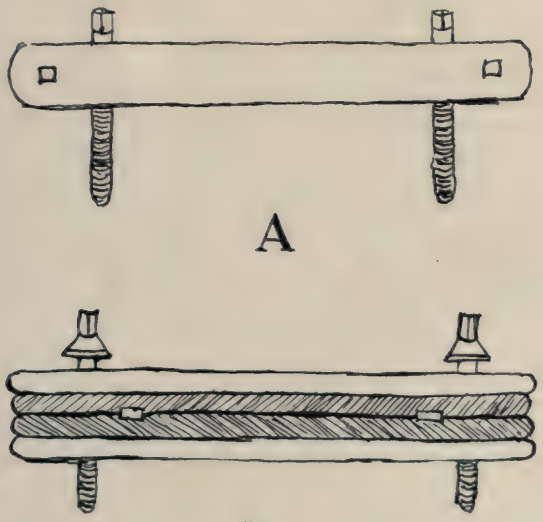

FIG. 4

It is evident that the method just described is not applicable to all cases of oblique fracture of the tibia, but only to those sufficiently near the centre of the shaft to leave room enough on either side for the firm insertion of the screws. It is also not indicated where other and simpler methods will suffice, or when the fracture is too old to permit of reduction of the fragments.

[1] The external fixation of bones by means of long screws and clamps was first introduced, so far as I am aware, by Keatley, of London. Since then many different clamps have been devised, including that of Clayton Parkhill, who did more to popularize the method than any other surgeon. Parkhill's clamp, and others which have appeared abroad, are unnecessarily complicated and difficult of application, owing to the various wings, nuts, and adjustments with which they are hampered. The apparatus described above is free from these objections and is so simple that it can always rapidly and easily be inserted. I first described it in the Annals of Surgery, 1904, vol. ii, p. 561. The various forms of these clamps may be obtained from W. H. Lauth, Metropolitan Building, Denver, Col.

Its usefulness might also be questioned in compound fractures with openings already so large that wiring could easily be done.

The statement is frequently made that external bone clamps are apt to lead to serious infection. I am convinced that this is not true, not only from my own experience, but from that of Parkhill and many others, and I wish to emphasize the following statement: *If the operation is a clean one, serious infection will not occur. On the other hand, if the operation is not clean, suppuration will take place with any method; but the results will be less serious in the presence of the drainage afforded by the screws of an external clamp; and, furthermore, in cases of infection these screws can much more easily and safely be removed than can buried plates, ferrules, or wires—with far less inconvenience to the patient and without the use of an anesthetic.* To this may be added that properly applied external clamps hold the bones more firmly than do wires or even internal ferrules or bone plates, and that when they are removed the danger of future complications is completely done away with.

It is, of course, always possible that slight infection may ultimately occur around the screws, although much can be done to avoid this by the occasional application of tincture of iodine to the surrounding skin; but if this should take place, it is of slight importance and does not spread, because the screws, like silkworm sutures, soon become walled off by a resisting cylinder of granulations, as do the nails in Steinmann's method of direct extension. And it should also be clearly understood that the danger of infection is especially slight in the procedure under consideration, in which the screws are inserted at a distance from the fracture, perhaps in normal tissues, through small openings in the skin.

It might be thought that such a large external clamp would cause discomfort; but it must be remembered that the greater part of the clamp *is* external, and that the portion within the tissues is limited to two moderate-sized screws, which are but little more bulky than a length of heavy wire and much less so than plates or ferrules. And, in addition, experience has taught

me that no discomfort is felt by the patient, as is also the case in Steinmann's method of treatment of fractures of the femur, in which heavy weights are suspended from nails driven into the femoral condyles.

The method I have described need not be confined to injuries of the tibia, but may be employed, with slight modifications, to appropriate fractures of other bones, which are not too deeply situated, and which possess sufficient stability to permit of the firm insertion of screws—such as the clavicle, the patella, the upper part of the ulna, the lower jaw, and under some circumstances the humerus and even the femur.

It is well known that certain oblique fractures of the clavicle and of the inferior maxilla are extremely hard to hold in position, while open operations for their relief are objectionable, for cosmetic and other reasons. Many more or less ineffective forms of apparatus have been suggested in their treatment, which, especially in the case of the jaw, often give rise to considerable discomfort, not to say suffering. There is no reason why these injuries cannot be effectually and comfortably handled by an external clamp inserted through such small openings in the skin that but trivial scars will result, it being only necessary to prevent the fragments from sliding past each other in order to achieve success, as I have demonstrated in connection with the jaw. The drills for this purpose, however, must be provided with an adjustable shoulder, and the screws with a permanent shoulder (Fig. 3, *c* and *f*), in order to prevent accidental perforation of the bone and injury to the subjacent structures. The tube through which the drill is inserted will prevent lateral slipping of that instrument. The clamps should also be small and made of some light material, such as aluminum, especially where the inferior maxilla is concerned.

It may also be suggested that screws are preferable to nails in applying extension from the condyles in fractures of the femur, because they retain a firmer seat in the bone and are not so apt to become rapidly loose. It is evident that they may easily be inserted by the method under discussion.

DISCUSSION.

Dr. John B. Roberts, Philadelphia.

I am much impressed with the elaborateness of Dr. Martin's apparatus, and I would be inclined to criticise this feature. Of course, one cannot do good work without good tools, but Dr. Martin's tools are seemingly unnecessarily complicated and cumbersome.

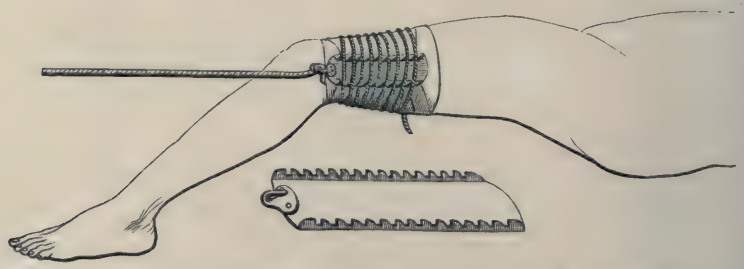

Fig. 1.—Levis' plate for applying extension to fracture of thigh when using compound pulleys to reduce displacement before direct fixation.

He speaks of pulling down the lower fragment with 100 pounds weight. Equally good results can be obtained, I think, by the ordinary *compound* pulleys connected with the limb with Buck's traction stirrup.

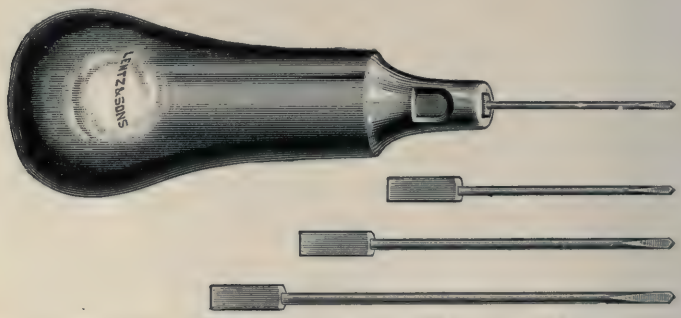

Fig. 2.—Roberts' fracture nails, with drill point and detachable aseptic handles.

I agree with Dr. Freeman that pins such as he describes would not cause suppuration of any moment, as a general rule, anymore than aseptic hooks for fracture of the patella, which I formerly used. If

they should cause suppuration, this process can readily be controlled by antiseptics and a small incision. A great deal is said at times about subcutaneous surgery being bad surgery, but there are a great many cases, such as those described in Dr. Freeman's paper, that give little trouble under subcutaneous fixation and are easily managed. Subcutaneous nailing in the manner which I advocated at the Edinburgh meeting of the British Medical Association about thirteen years ago may often be valuable.

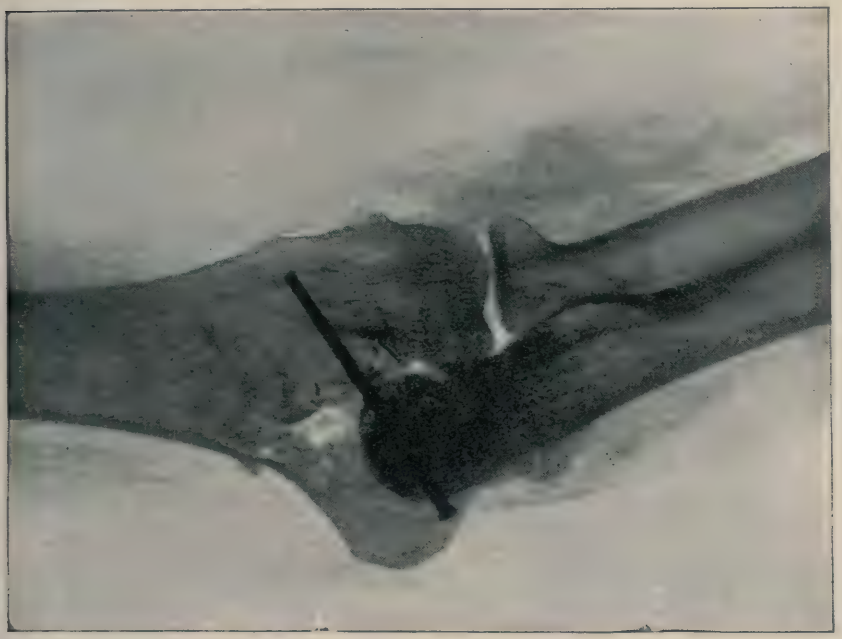

FIG. 3.—Fracture of internal condyle of humerus fixed with a wire nail. (Experimental.)

DR. THOMAS W. HUNTINGTON, San Francisco.

This is a subject which has interested me for several years above all other subjects in surgery. I am led to believe that this is a new department in surgery, and in evidence of this statement I want to say that in 1907 I sent to the members of this Association and to other leading surgeons in this country a list of categorical questions, among which was the question: "Are you in favor of the open treat-

ment of recent fractures?" The question was perhaps not distinctly understood, for I found that only about 18 per cent. of all the men to whom the questions were sent acknowledged the propriety of interference from the operative standpoint in the treatment of recent fractures. Very recently I have sent another list of questions, containing this original question, to over 100 surgeons, and of these, 85 per cent. agreed to the propriety and safety of the operative treatment of recent fractures. I consider this a most interesting development, considering that only four years ago there were but 15 per cent. who answered the question affirmatively.

I wish to call attention to an important factor in dealing with recent fractures. We must adopt this rule: The least possible foreign material must be placed under the skin, with a reasonable hope of it being retained in perpetuity. It must be distinctly understood that it does not necessarily negative the general question as to the propriety of operative procedure, even though we do now and then have to remove a plate, staple, or wire; but the fewest possible removals will tend very largely toward establishing the legitimacy of this undertaking.

With regard to the foreign material to be employed, you will with experience arrive at a point where you will find that a foreign body of a certain size will be retained oftener than a larger one. I believe that material can be minimized by the use of the staple. I do not insist upon its adoption by everyone, because it requires special skill and dexterity for its use. When using a plate I would suggest that a thin plate be employed. It is a small foreign body and is easily handled.

With regard to the fixedness of the staple or plate, in 30 cases of operative treatment of recent cases in my own experience we have found very little difficulty in maintaining alignment, with very small light materials. I never expect to have any disturbance if I succeed in getting a kindly healing with a staple, but I do insist on the careful application of plaster of Paris as a supporting outside feature after having established the foreign body within the wound.

A point which I have found of great benefit is that the farther away from the skin you can place your foreign material the more secure you are in maintaining it permanently. For that reason, in operating on the tibia where the foreign material must lie fairly near the skin, I am careful to place my staple or plate away from the line of incision, letting it be covered by healthy skin, and so avoiding the immediate contact between the foreign body and the wound.

I will show one picture illustrating what I regard as the most difficult of all long bone fractures either from an operative or conservative point of view. This picture is one of fracture of both bones

of the forearm in a young girl. It was treated with a staple in the radius, and now, fourteen months after the injury, both form and function are perfectly restored.

Dr. A. T. Bristow, Brooklyn, N. Y.

It seems to me there is no more important subject for discussion than this of the open treatment of recent fractures. I have myself operated on 11 cases this winter by the open method, and in every case but one the results have been good. We are particularly fortunate in hearing this paper by Dr. Martin, in which he tells us not only of his successes but also of his failures, for I think our failures in surgery are of much greater value than our successes.

In my opinion the open treatment of fracture should be restricted to the following cases: (*a*) Cases of persistent non-union; (*b*) cases in which serious and disabling deformity has followed or is likely to follow the usual methods; (*c*) cases already compounded. We ought not to be led into dangerous methods of treatment when safer methods avail, and we ought to remember that the preservation of perfect function without visible deformity is not inconsistent with a radiograph which apparently shows some defect in alignment.

One of my cases was in a man, aged fifty-eight years, a heavy-set German, who came under my care some five weeks after the accident which fractured his femur. There were more than two inches of overriding, a great deal of callus, but no union. I knew that meant a long incision, disturbance of soft parts, and I was thoroughly impressed with the perils of the operation, but I also considered that if I did not try to better his condition I would be turning a cripple on the State. I therefore used all ordinary and all extraordinary precautions. It was an extremely difficult procedure, as is always the case in this class of cases. I was finally obliged to cut off an inch of the bone, although we did the best we could, two powerful men pulling, but could not get the bone down because of the callus. I was dealing with tissues of low resistance, and therefore decided on the minimum of interference. I got the bones together on an 8-hole Lane plate, and then gently but thoroughly cleansed the wound with salt solution and closed it up and put on a long plaster cast from axilla to toe. The temperature never went over 99°, and there was a complete and satisfactory recovery.

In a case of fracture of the femur at the neck, with vicious union and great shortening, it was necessary to chisel the bone apart at the neck, placing the limb in abduction in a plaster cast. No disturbance followed the extensive operation, and a window was not cut in the cast until four weeks after the operation.

The other cases were three cases of ununited fracture of humerus, a case of ununited compound fracture of the femur in a boy, aged ten years; two cases of compound fracture of the tibia; one case of vicious union of fracture of radius, with loss of supination; one case of compound fracture of tibia; one case of compound fracture of the neck of the humerus. None of these cases did badly save the latter, which developed a pneumococcus infection of the wound. This ought not to be ascribed to the operation, as the fracture was compound. On the other hand, a case which gave me great anxiety was the following:

A young chauffeur was brought into my service with a fracture of both bones of the leg and bad over-riding of fragments. There was a great deal of displacement, and operation seemed justifiable and necessary. The open operation was accordingly done rapidly, a 4-hole plate adjusted, and the wound closed. In thirty-six hours there was a streptococcic infection of the wound, which necessitated prolonged drainage. Now, five months later, the man is just beginning to get a little union and to be allowed to walk about on crutches. Every precaution was taken in this case, and yet infection occurred. We fail to take into consideration the possibility of a hematogenous infection from the throat or tonsils. We operate, the patient becomes infected, we jump to the conclusion that the infection is the result of the operation, when it may be a hematogenous infection and not by way of the wound. The possibility of such an occurrence ought to make us doubly cautious when we turn a closed fracture into an open one.

Dr. Joseph Ransohoff, Cincinnati.

I am very glad to learn, from the tendency of the discussion thus far, that the American Surgical Association will probably not give its sanction to indiscriminate operation for fractures. Eight years ago I read a paper on this subject, the opening of closed fractures in order that they might be wired, and I took then the ground I take today, perhaps a little less conservatively now than then, but, nevertheless, I then recognized fully the great danger that would come to people suffering from fractures if every fracture in which there was the least tendency to deformity or functional limitation were treated by the open method. That is a method of treatment that should not be generalized, in my judgment, for the reason that I consider one of the most dangerous operations the open treatment of fracture of the femur in hands not thoroughly competent in everything pertaining to surgical technique. I had one death myself years ago, I know of another death from hemorrhage, and one death was alluded to today in a case in which a recent fracture of the femur was operated upon.

A most important point is the time when an operation is to be done. I think either at the time of fracture or within a week or ten days at the very latest the surgeon should make up his mind whether it is a case for operation or for treatment without operation. Just as in fractures of the patella the danger from operation lies in selecting cases for operation which have been treated without success by conservative means. The longer one waits after a fracture, the longer the deformity exists, the muscles shortened and periosteum thickened, the more difficult to reduce the fracture or wire it, the more difficult it will be to keep the parts in apposition because of the shortened muscles, and the greater will be the danger.

Dr. Huntington states that four years ago only 15 per cent. of the surgeons in this country whom he consulted were in favor of opening the fractures, while now 85 per cent. are in favor of this method. This tremendous change of sentiment has affected the profession. It is now at its acme, and we will again come down to the normal level when the cases will be selected according to their merits, and the proper time for their operation will be also selected. This bone plating is not new. In my article eight years ago I reported some cases in which we plated—we did not use the metal plates, but the ivory plates, which were identical in construction, having also perhaps the advantage that in the course of time the ivory and screws would be absorbed without any difficulty. I am not going to speak of other fractures at all, but want just to allude to fractures of the femur. These, when operated on, are a source of danger. We cannot eliminate that feature. I always teach that one cannot pull too hard on the femur. The ordinary weights that are put on femurs, 10, 15, and 20 pounds, are useless, for it takes 45, 50, and 65 pounds to overcome the pull of a good strong musculature such as that of the thigh, and if we use such heavy weights I am sure we can reduce a number of cases of fracture of the femur in which wiring could be done. It would be just as well by driving it through the os calcis, as is done by Bourdevilla, of Bologna. I still treat a good many fractures without wiring, and I have not yet been seized for malpractice.

Dr. Fred B. Lund, Boston.

I do not think that there is any great danger, after a man has done one or two of these operations, for a wave of enthusiasm for this method of treatment to spread over him, for the operations are too difficult. I confess to being one of those who have for many years treated fractured femora by the method of walking past the bed. One reason we have not been more in favor of operating on the femur

is because our methods have not been efficient. I have operated successfully with wire, but the anatomical results have not been as good as they should be. These plates, however, to my mind offer the most efficient means of external splinting which has been placed at our disposal.

I do not agree with Dr. Roberts that the material used by Dr. Martin is too cumbersome; we must have everything appropriate for the work in hand. The earliest cases I have operated upon have been three weeks after the accident. I have done 13 cases, all showing poor results from conservative treatment. If by the *x*-rays we can operate earlier, it will be a great step in advance, for there will not be so much callus to clear away. The oblique fractures of the tibia are well adapted to the plate method, although they may later necessitate taking out the plates. The plates are good also in fractures in old people and people who will not bear cumbersome apparatus. I had a case of fracture of the humerus in an old lady in which I tried three times under ether to reduce the fracture unsuccessfully. A plate was put in, and she was thus made very comfortable.

I have had no case of serious infection, although I have had to take out two plates on account of suppuration, one three weeks and one twelve days after operation. Both cases were fractures of the forearm, which often need operation and are most difficult because of the smallness of the bones. In these two cases I used too heavy plates. Make your foreign body just as small as possible. If you are going to plate the femur, first be sure you have a strong apparatus, and second, consider the size of the foreign body which you are inserting.

I thoroughly agree that this plating of fractures is worth all the trouble it takes, even though we do occasionally have to open up again to remove the plates.

Dr. Arthur Dean Bevan, Chicago.

My old teacher of surgery, whom many of the older members of this Association knew, Moses Gunn, was very fond of telling us students that the practice of surgery should be the practice of common sense. Last year I had the opportunity of seeing a surgeon with a very good technique plate a fracture of the femur which was in very good apposition; the fracture was probably 6 or 8 inches in length, the apposition as good as in any fracture of the femur I have ever seen; and in the same sitting at the same clinic this surgeon applied a plate in a Potts' fracture where the deformity could have been corrected by a little manipulation and a plaster-of-Paris cast. This surgeon had adopted the plating operation as a routine for the treatment

of simple fractures. I think he did not live up to Gunn's rule. I have little or no sympathy with the general adoption of the open method of treating simple fractures, but I believe the open method of treating fractures has a very distinct place and is of very great value, and that we should apply it to cases in which we find from experience that we cannot obtain a good, useful, functional, and clinical result by less dangerous procedures. I believe that from this time on we shall do more open operations for fractures. There is a very distinct danger, however, when an association such as this one places its stamp of approval upon the indiscriminate and routine method of treating simple fractures by open radical means. I had the opportunity last fall of seeing Dr. Martin plate a fractured femur, and I think it was one of the best pieces of work of this kind I have ever seen. I was very much impressed with the value of the extension apparatus which he has described today, and at an early operation I adopted this method. I found, in operating upon a fracture of the femur by Martin's method and with his tools, that it was necessary to apply about 100 pounds of weight to bring the fractured ends in apposition, and then when I removed the canton flannel which was used as a sterile material for making extension, I found it difficult to maintain that extension, and I have this suggestion to make: Instead of using sterile muslin or canton flannel, as suggested by Dr. Martin, drill a hole through the upper end of the lower fragment of the femur, using the same drill that is used to bore the hole for the screws. Pass through this hole a good-sized wire cable, the same material that is used for hanging heavy pictures. Have the cable sterile, of course. This is properly secured in place. To the other end of the cable, which runs over a pulley, is attached the necessary amount of weight, varying from 50 to 100 pounds. Gradually the shortening is overcome, usually within eight to ten minutes, and then with the extension still applied, a steel plate is put on and screwed into place. The cable is then removed and the wound closed, and a plaster cast put on in the usual way. I think it might be well to make the skin closure with fine iodine gut, so as to avoid the necessity of opening the cast to remove the stitches.

Dr. Maurice H. Richardson, Boston.

I have been very much interested in this discussion. I am particularly pleased to hear Dr. Lund bring out some of the bad results that may follow and have followed the open treatment of fractures. The proposed open treatment of simple fractures is so great a departure from all previous methods that it must not receive any endorsement that carries real weight unless everything that can be learned about

the method, the good and the bad, but especially the bad, be frankly admitted and discussed. Dr. Lund's frankness is what we want imitated by everybody.

My own views of the matter are influenced largely by what I have seen in the open treatment of patella fractures, and I neither advise nor perform operation unless the indications are perfect. From the point of view of the patient I would not permit the conversion of a simple into a compound fracture, unless, first, the surgeon were a man of great skill and experience, and secondly, the result without operation was pretty sure to be bad—to be much below the average for the fracture under consideration.

I have seen too many disasters in knee-joint surgery to permit the opening of that joint when good results are possible without opening it. When all results are, on the whole, good in simple fractures, without making them open, I believe in treating them as simple fractures. When all results are bad in fractures thus treated, I would try the open method. When, on the whole, there is much to be gained by operating, and no forbidding contraindication is present, I would operate.

In Dr. Freeman's suggested fixation of oblique fractures of the tibia the danger is reduced to a minimum, but even under such circumstances there is grave danger if the method is applied by men of inexperience in surgery. In the hands of the skilful and experienced this method has everything to commend it.

The open treatment of all fractures should be considered at the present time a specialty, and should be left to those men who have special skill in surgical mechanics and who exercise great care in aseptic technique. The last thing I did before coming to this meeting was to attend a consultation in the case of a simple fracture which had been converted into an open one by a man without special experience. At the consultation it was a question of saving life by amputating a thigh above a fracture made septic by operation.

Unless this Association states most emphatically that the open treatment of fractures must not be a routine measure, but is to be used only in most carefully selected cases—cases in which only very poor results can be obtained by other methods—we shall soon have a host of incompetent operators converting simple into compound fractures. There will then be no comparison between the good results of the old methods and the evil results of the new. I approve of the open method in rigidly selected cases, in the hands of skilled surgeons, but only when the indications are of the strongest, and the surgeon's skill of the highest and his experience of the broadest.

Dr. Alexander Primrose, Toronto, Canada.

I have had a somewhat limited experience in treatment of fractures by plating. In my clinic there have been performed some 36 such operations, my colleague, Dr. F. N. G. Starr, having done the majority of them. I must say the cases were most carefully selected, so that no case was subjected to operation in which we found we could obtain a good functional result by other means; and I am inclined to think surgeons will eventually come to that conclusion unanimously.

Dr. Martin referred to the possible loosening of the screws. That seldom occurs in the thick compact tissue of the centre of the shaft of a long bone, but probably in approaching the articular extremity of the bone, where the covering of compact tissue is very thin and the screw almost immediately enters cancellous tissue, loosening may occur, due to rarefying osteitis.

A point which has not been brought out in this discussion is the value of plates in the deformity caused by rotation; here this method of treatment is very useful. Cases of fracture at the upper end of the humerus afford a good illustration. For example, a patient recently was under treatment in my clinic with a fracture through the surgical neck of the humerus where the upper fragment was rotated outward to an extreme degree and it was quite impossible by any manipulation to bring the fragments into apposition, nor was it possible to determine accurately the position of the upper fragment until it was cut down upon. By the open method it was a simple matter to rotate the arm to meet the upper fragment and to secure accurate apposition by means of a plate; the arm was then restored to a comfortable position, and a perfect result was obtained.

The question has been raised as to whether or not plates should be inserted in cases of compound fracture. Some advocates of the open method strenuously oppose their use in these cases. My experience does not agree with their conclusions; I think even in a septic wound where there is efficient drainage the plate is of value, and by affording stability is a source of great comfort to the patient.

Dr. Arpad G. Gerster, New York City.

I also wish to put myself on record as to the propriety of selecting the cases that are to be subject to the open method of treatment, and also to say that it should be performed only by those thoroughly competent to carry out this operation.

I would call the attention of the Association to one part of the skeleton where I think the plates are of great value—I refer to fractures, generally comminuted, involving the lower end of the humerus, of the T- or Y-shape, where one or both condyles of the humerus have

been broken off in such a fashion that no amount of manipulation or fixation by the older methods will be sufficient to reduce the bones into the normal position, and especially to so retain them. In several of these cases I have found the plating of very great value and the results were very good. No irksome dressings were necessary, the union being very prompt and the functional result excellent.

Dr. M. L. Harris, Chicago.

I wish to express my agreement with the last statement made by Dr. Martin, to the effect that to secure good results in this kind of work it is absolutely essential that we have suitable instruments. There is no class of operations that the surgeon is called upon to do in which the result depends so absolutely on suitable instruments with which to work.

We have at the Alexian Brothers' Hospital, where we have a very large fracture service, what we know as the Lemon-Mueller apparatus. This, in brief, is a very large, heavy metal frame, in which the patient can be placed and extension made upon the legs to any degree and in any direction. This we have found the most valuable adjunct in the treatment of fractures. The patient is placed and fixed in the apparatus; in fact, is anesthetized in the apparatus. The legs are entirely free from the perineum to the foot. The fracture is cut down upon, extension is applied, and with large forceps absolute apposition is very easily secured, and with almost no manipulation or touching of the bones. We have not met with an over-riding fracture of the femur which could not be adjusted by this apparatus. The plate can now be applied and the wound closed. This, as has already been stated, requires the acme of technique. Opening the peritoneum is a simple and safe matter compared to the open treatment of fractures. Given a most careful technique, there is then necessary suitable apparatus; without suitable instruments one but invites disaster who attempts to treat fractures openly.

The use of the plates in compound fractures of the leg we have found to be extremely useful, particularly in the severe compound fractures of the leg ground full of dirt, in which there is certain to be suppuration. These fractures are extremely difficult to maintain in apposition by any method of dressing, because they must be kept open and dressed daily, and it is almost impossible to hold the bones in apposition under such circumstances. In these cases I have used the plate, knowing that it must be removed later, but the plate holds the bones in apposition, forms a simple, easy fixation dressing with the wound open, thereby materially facilitating the dressing of the wound, and also shortens the time of healing of the bones.

Dr. James E. Moore, Minneapolis.

I am glad to hear that it seems to be the consensus of opinion that the open treatment should be applied only to selected cases; I think it is equally as important that the surgeon should also be selected. I have arrived at this conclusion from my experience in consultation work, as I have frequently seen bad results from this method because performed by the occasional operator. To my mind, no occasional operator has any moral right to perform this operation, which requires the greatest skill and surgical technique.

Dr. Stanley Stillman, San Francisco.

There are certain general underlying principles that must not be overlooked in this discussion. In the first place, neither bone, fascia, nor fat can be retained in a given position by wire, silk, catgut, or plates, if there is constant tension or traction tending to separate these parts. What is true of fat or muscle is equally true of bone, only a longer time is required. The idea of using plates with screws or nails or staples to avoid the employment of external support is erroneous. I regard the employment of external support of the highest importance in connection with the use of internal splints; that is, any sort of apparatus retaining the bones directly in place; and I aim also to include the joint above and below the fracture in the support. Under such circumstances, after the fracture has been thoroughly reduced and held in place by some form of internal splint, there is little tendency for screws or staples to become loose, and the thickness of the plates need not be very great. In my own work I use very thin plates and depend upon the plaster-of-Paris rather than the plate to prevent subsequent displacement. It is fifteen years since I began using silver plates in the treatment of fractures. In compound fractures of the leg, or in cases where the swelling is so great that difficulty is encountered in suturing the soft parts after the application of the plate, I have frequently not sutured at all, but simply applied an aseptic dressing covered by a plaster-of-Paris cast, which is left undisturbed for a month, at the end of which time the plate is found covered with granulation tissue. I then remove the plate and apply a more closely fitting plaster-of-Paris dressing. I have seldom had any difficulty with these cases. In a case of a large, heavy, fat individual, I think the use of a plate is imperative. In these cases, before making the incision, I so arrange the patient that a plaster-of-Paris dressing can be applied without moving the patient and without releasing the extension until after the plaster-of-Paris is applied. The bone is then exposed, plated, the wound sutured and dressed, and plaster-of-Paris applied—taking

in the pelvis and extending to the heel—and allowed to set before the extension is released or the patient moved at all. The patient can then be moved and turned without danger of displacing the fragments. A small thin plate has answered perfectly in my hands. In transverse fractures of both bones of the forearm it is often extremely difficult to reduce the fracture even after the bones are exposed; but when this has once been accomplished, there is little tendency to displacement with proper plaster-of-Paris dressing, and I have frequently dispensed with any form of internal splint. I do not think that anyone should undertake the open treatment of fractures unless he has had more or less experience with ordinary carpenter's tools; and for one who has had such experience no very large armamentarium is required. I have noticed one thing in regard to fractures treated by the open method, and that is, where the reduction has been so complete and accurate that the line of fracture can hardly be discerned, the time required for firm union is very much longer than where a moderate amount of displacement exists. The amount of callus thrown out is very much smaller under such circumstances.

Dr. Charles A. Powers, Denver.

We are greatly indebted to Lane, Martin, Lambotte and others who have done so much to perfect the operative management of closed fractures. They have taught us that very many cases which in the older days came out badly may now be attended by a good result under operative management. Our knowledge in this direction has advanced, and will advance still farther. At the same time I venture the thought that these cases definitely requiring operation, or, if I may so put it, better managed with operation, will prove to form a very small percentage of all fractures seen. We have at this time, in all parts of the country, a very large number of surgical operators, and I believe that in addition to the further improvement in operative technique there is room for more careful selection, by the rank and file of operators, of the cases demanding operation. We are not to lose sight of the established fact that a satisfactory or even perfect functional and cosmetic result may occur in certain cases in which anatomical reposition is lacking.

Dr. Kenneth A. J. MacKenzie, Portland, Oregon.

My service is very largely an emergency service, and I see a large number of cases of oblique fracture of the tibia and fibula, and formerly when the method of treatment in vogue was the use of plaster-of-Paris bandage circularly applied it was a common incident to find

deformity and impairment of function. The adoption of the plaster bandage, first made by Stimson, has proved most successful in my practice. Occasionally I found the use of silver wire was sufficient, but in no case of this kind have I found it necessary, since adopting Stimson's plan of plaster bandaging.

I have had quite an experience with fractures of the femur, and have been surprised to find in the majority of instances that the functional results have been remarkably good, even though examination with the *x*-rays shows the position of the fragments to be faulty.

Dr. Edward Martin. The discussion of this subject has at least developed the opinion which seems to be held by practically all the surgeons present, to the effect that the open treatment of a fracture is not to be selected as the routine method, but is to be employed only when it is obvious that by more conservative means satisfactory functional and cosmetic results cannot be obtained. Transverse Fractures of the Femoral Shaft was selected as the subject of my paper because such breaks are peculiarly difficult either to reduce or hold in reduction without operation, and if they are cut down upon, there can be little doubt but that the best surgical procedure is the application of a plate held in position by screws. Thus the discussion of the question becomes more limited and therefore more detailed and serviceable. The many *x*-ray pictures illustrating the course and results of the open treatment of these fractures show that even in the hands of those both generally and specially skilled such results are by no means uniformly perfect.

There has been a wave of enthusiasm sweeping the country incident to the publication of a few thoroughly satisfactory and uncomplicated cases. As a result of these publications surgeons who operate occasionally or those just out from hospital service are prone to imagine that the open method of treating fracture of the femur is a safe and an easy one, requiring for its proper performance ordinary cleanliness, a plate, screws, and screwdriver, and are, therefore, at times tempted to perform this operation on cases which could be more efficiently treated by conservative methods and to employ inadequate tools.

There is certainly some mortality incident to this method of procedure which has not become a part of current literature, and also a number of thoroughly unsatisfactory results with permanent crippling which might have been avoided by a more thorough knowledge of the difficulties which these cases may present and of the need of special tools and appliances. The cumbersomeness of the armamentarium employed has been criticised, but somewhat unjustly, since the operation is essentially one of tools.

In Dr. Primrose's discussion he said that if the operation be done carefully, and if the bone be absolutely fixed and held fixed and the wound be kept clean, there is no danger of the screws loosening. This is undoubtedly true. Indeed, Bartlett's experiments have shown that a screw once driven in the bone will hold firmly, even though infection takes place. When, however, such screw or screws are subject to even a slight straining motion, which is continually repeated, loosening inevitably occurs. I have never been able to so firmly fix a fracture of the femur, even when eight screws were employed, but that on straining and twisting the crack of junction could not be made to widen and close at least enough to be distinctly perceptible. If this very slight play is kept up by muscular action the loosening of the screw is inevitable, hence the need of fixation by external splints after the insertion of the plate is practically as great as it would have been had no plate been inserted, and, moreover, this external fixation must be most accurate and efficient. My own feeling is that it is best attained by the use of a plaster cast. When, however, a patient with a broken femur is enormously fat, though it is still possible to apply a plaster encasement, it is obvious that its retaining influence upon the bone must be very trifling.

In regard to the treatment of compound fractures, we swab these out with tincture of iodine and apply plates where these are indicated. Where they are not we apply either a simple internal suture or none at all.

Bevan's method of traction is extremely ingenious, and under some circumstances would seem highly desirable. We habitually use overtraction, *i. e.*, cause an actual lengthening of about one-quarter of an inch, since muscular spasm is thus completely overcome and on releasing the traction the bones will drop easily into their proper relation one with the other.

Dr. Freeman. A great deal has been said about the careful selection of cases, with which I am in hearty sympathy, but I wish someone had told us how to select them. A few points which occur to me are: (1) We should not operate except under the most favorable circumstances, and the surgeon should be thoroughly familiar with aseptic work. (2) The age and general condition of the patient should be considered, some being as old at forty as others are at sixty-five or seventy. The patient's position in life and occupation must be thought of, for some people can afford to put up with more or less deformity, while others cannot. (3) We must also remember that the deeper seated the bone the more danger there is in operating. (4) We should also take into consideration the amount of manipu-

lation necessary—an old fracture of a number of days' standing being harder to handle than a recent fracture. It must likewise be realized that fractures with deformity sometimes give very good function, and we should not be too anxious to get the bones into exact position. And, above all, we must take into consideration the danger of sepsis, and of delayed or non-union. It has been my unfortunate experience to come into contact with a number of such results after operative work. In 9 cases out of thirty-four I got delayed union, and in 2 cases pseudarthrosis.

About the use of bone plates. They are extremely popular at the present time, yet I do not think we should lose sight of what Parkhill took such pains to prove, that we can use external clamps safely and with great advantage. And I wish to say again, as I said in my paper, that we should not be too much afraid of suppuration in the use of external clamps, and when two screws are put in each fragment and firmly plated together outside instead of inside the tissues, they hold the bones very firmly; there is no danger of their giving way. It is not necessary, when two screws are used in each fragment, to resort to tight splints or plaster casts, which may sometimes lead to ischemic paralysis, etc. We can take these external screws out readily, and if infection occur it is much less dangerous and more easily handled than with an internal plate.

I want especially to call attention to the use of external clamps in compound fractures. What is the use of burying a plate in the tissues and taking it out afterward? If suppuration is apt to occur, why not use an external clamp with two or even one screw going into each fragment, which can be removed without discomfort to the patient and without a general anesthetic?

Dr. MacKenzie's remark, that most oblique fractures of the tibia can be treated by plaster casts, if properly applied, is, of course, true. He also said there were exceptional cases where wires should be used. The external clamp is for the purpose of avoiding the use of wires in these exceptional cases. A large opening and considerable disturbance of the tissues is necessary for the introduction of wires. External screws may be inserted through very small openings and are for the purpose of avoiding open operations and the dangers of infection and of delayed or non-union.

EVERTED DORSAL DISLOCATIONS OF THE HIP.

By OSCAR H. ALLIS, M.D.,
PHILADELPHIA.

WITH THE REPORT OF A CASE MISTAKEN FOR FRACTURE OF THE FEMORAL NECK.

By JOHN B. ROBERTS, M.D.,
PHILADELPHIA.

In this variety of dislocation the foot is everted, while the head of the femur lies outward upon the dorsum of the ilium. This form of luxation of the head of the femur may be primary or secondary. By primary I mean that the head of the bone escapes from the socket while the femur is in a condition of external rotation, and the dislocation occurs with all the signs of dorsal dislocation *reversed*. In other words, the ordinary dorsal dislocation is attended with adduction of the knee and rotation inward of the femur and foot; and when the patient lies on his back the trochanter will be on a higher plane than the dislocated head, with the latter pointing inward and downward; while in dorsal dislocation with eversion of the foot, the femur will not be adducted nor will it be rotated inward, but both the femur and the foot will be turned outward and the great trochanter, instead of being on a higher level than the dislocated head, will be at a lower level, when the patient is in the supine position.

I have seen one case of undoubted primary everted dorsal dislocation of the hip. A middle-aged man was leading a horse on a smooth icy road, when the animal reared, slipped, and fell. The horse fell upon the man, rendering him instantly helpless.

He was conveyed to his home by a policeman, and through the courtesy of Dr. W. Stillwell I saw him an hour after the injury, before any attempt had been made at reduction. The limb was abducted and flexed slightly at the hip and knee, occupying a constrained position, with the foot turned outward. The reduction was accomplished under ether in the following way: The pelvis of the patient, lying on his back, was first fastened securely to the floor by means of muslin bandages passed through hooks in the floor, situated at the borders of the pelvis and at the perineum. The leg was flexed on the thigh, the thigh on the pelvis, and traction was made directly upward until the head of the femur reached the level of the socket. The traction was next made inward toward the umbilicus, in order to bring the head over the socket, then the knee was carried downward and the head of the bone was found to have come into place. The patient returned to work in a few weeks.

Experimental work has demonstrated the possibility of primary everted dorsal dislocations. With the cadaver strapped firmly to a suitable table, the femur should be flexed to a right angle with the pelvis and the leg at a right angle to the thigh. The operator, standing on the right side, should steady the right knee with his left hand, and, seizing the right ankle with the right hand, should rotate the femur by turning the ankle like the spoke of a wheel inward toward the pubes, with the femur slightly adducted. The rotation ruptures the capsule and the head falls outward. Then, if the limb is extended the symptoms of dorsal dislocation with eversion will be present. I have repeatedly produced the luxation by this manipulation, but have quite as frequently fractured the femur in the undertaking.

The secondary variety may be produced through unspent forces converting a primary dorsal with inversion into a dorsal with eversion, or, as is not uncommonly the case, it may occur as the result of unsuccessful attempts at reduction by means of manipulation with circumduction. This method has repeatedly converted a dorsal dislocation into a pubic or obturator,

and not infrequently has converted a dorsal with inversion into a dorsal with eversion. In the case reported by Dr. Roberts, attempts had been made to restore motion to a joint stiffened by chronic synovitis. In doing so the capsule, which was softened and weakened by inflammatory processes, gave way, dislocation took place, and in attempting to restore it the condition shown in the *x*-ray picture was produced.

AN EVERTED DORSAL DISLOCATION (SUPRACOTYLOID) OF THE FEMUR MISTAKEN FOR FRACTURE OF THE FEMORAL NECK.

Reported by Dr. Roberts.

A rather stout married woman, aged twenty-six years, was put under my care for surgical treatment at the Methodist Hospital in November, 1910. She was evidently in good general health, but was confined to bed in the supine posture, because of pain and rigidity of the right hip and knee. She was unable to move the limb, and complained of great pain when any attempt was made to handle it or make an examination by means of active or passive motions.

She was free from fever, had a good appetite, and was cheerful and happy if allowed to remain undisturbed, lying on her back with the two lower limbs parallel to each other. The right lower extremity was slightly edematous over the tibia, appeared to be somewhat atrophied, and lay upon the bed in marked eversion with the heel about opposite the internal malleolus of the left tibia. Voluntary motion of the limb hurt her, she said, and therefore no movements were made. Attempts at rotation made by me caused her to cry out with pain or fright, though some rotation was evidently possible. Passive flexion of hip and knee were impossible, but how much of the rigidity was due to pain and fear I could not determine.

Measurements from teeth, umbilicus, or anterior iliac spines to the malleoli showed the right limb to be about one and three-quarter inches shorter than the left. Measurements from the

trunk to the patellæ and from the patellæ to the malleoli seemed to prove that about one and one-quarter inches of the shortening existed in the femoral section of the limb and about three-quarters of an inch in the tibial section. These measurements,

FIG. 1.—Everted dorsal (supracotyloid) dislocation of the right hip-joint. Front view.

as is well known, are difficult to make with accuracy. Measurements to establish the relative position of the two great trochanters by the so-called Bryant's triangle gave about one and one-half inches' displacement upward of the right trochanter.

When the patient was turned on her abdomen the right

buttock was flattened, and the right leg appeared to be shorter than the left from trochanter to *heel* by about one and one-half inches. No kyphosis of the spine was found, and no definite account of a fracture of the limb was obtained.

My attempts to obtain a clear history of the condition previous to my first interview were unsatisfactory. After eliciting the objective facts just mentioned, I concluded that the woman was suffering from an old fracture of the neck of the femur, a rigid knee from continued immobility in the extended posture, and a hysteroidal condition of the nervous system.

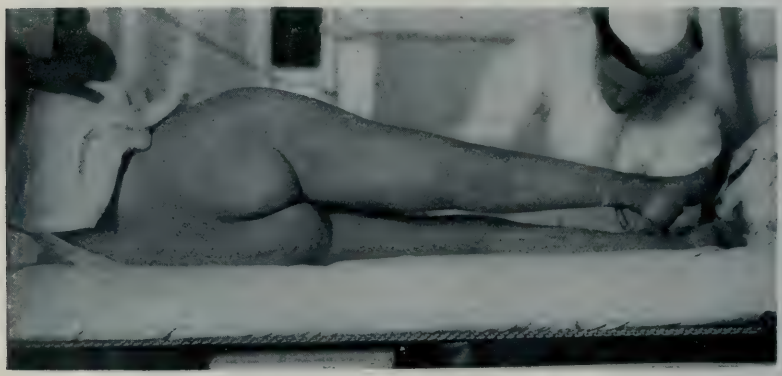

FIG. 2.—Everted dorsal (supracotyloid) dislocation of the right hip-joint. Posterior view. This photograph was taken with the patient lying on her left side, because her nervousness made it almost impossible to get her to stand up again after the anterior view had been obtained.

The antecedent hospital notes were surgically rather desultory, but from them the following information was obtainable. The patient had been admitted about six weeks prior to my seeing her. She had stated that the present trouble dated from January, 1910, when rheumatism occurred in both legs. It was more severe in the right hip than in the left, and increased so much that she became delirious. The right leg became swollen and edematous. This condition had lasted until she was admitted to the hospital. Then the right knee was found to be stiff in the extended position, but the principal trouble was the great

pain in the hip of the same leg. Temperature, pulse, and respiration were normal. The examination of the chest, abdomen, pelvis, and urine were negative, and nothing unusual was found in her menstrual history. No tubercle bacilli were found in the blood.

The woman herself gave as her opinion that the hip trouble might have developed from a fall sustained four or five days prior to the onset of the pains, which her family physician had called rheumatism. At that time she had bruised, however, the left leg only, did not seem much hurt, and had walked freely afterward.

Four years previously she had given birth to her youngest child, six weeks after which she had had what was called typhoid fever for a few days. Prior to these occurrences there had been a sore on the vulva, but no subsequent symptoms had developed.

When admitted to the hospital the right leg was everted, being painful and tender over its whole extent and helpless as to voluntary motion or usefulness. The woman could not stand or walk, and had been in bed for several months. There was slight pitting on pressure. Sensation was preserved. The right leg was somewhat smaller than the left in circumference, and is described in the hospital notes as being shorter than the left.

Sometime after her admission an *x*-ray plate was obtained and the report made that the skiagraph was negative as to pathological findings. Two weeks before I saw her the attending surgeon had the patient etherized and made passive movements of the hip. The thigh was flexed at a right angle and the limb then abducted and adducted to break up adhesions at the joint. The head of the bone moved under these manipulations. It gave the operator the impression that it became luxated and was replaced, but would not remain in the socket. I understood that he thought it possible that there had been originally a fracture of the rim of the acetabulum, because that cavity seemed to permit the femoral head to slip out and in very readily. After these manipulations the leg measured in length

about two inches less than the left limb. The patient was returned to bed and continuous traction with weights applied.

After making the diagnosis of probable old fracture of the neck of the femur, I renewed my efforts to obtain a personal view

FIG. 3.—Ankylosis of the right hip-joint as shown by skiagraph taken before manipulations were made to break up the adhesions from previous arthritis. In printing the right hip has been made to appear to be the left.

of the skiagraph taken before she came under my care, and had several skiagraphs taken in the laboratory of the hospital.

After a series of delays both objects were attained. The lesion was instantly clear. The first skiagraph showed the existence of an arthritis of the hip-joint, which had not been

reported to the surgeon in charge, though the adhesions found under anesthesia had revealed such a condition to him. The second skiagraph, which was made after I had been given charge of the woman, revealed a posterior dislocation of the head of

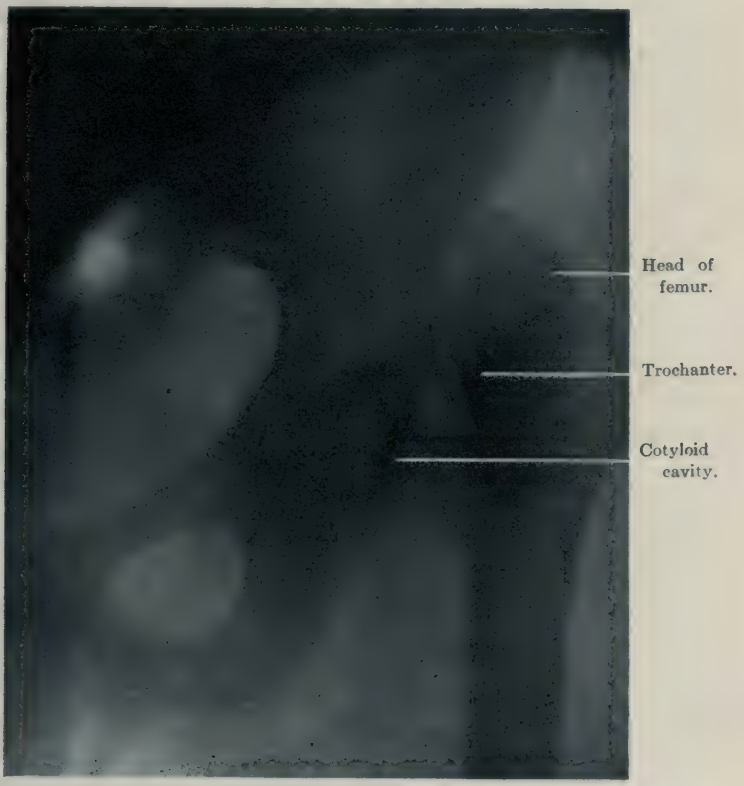

FIG. 4.—Everted dorsal (supracotyloid) dislocation of the right hip-joint. In printing the right hip has been made to appear to be the left. The white line indicates the great trochanter and is much too long.

the femur, with eversion of the limb. The head of the femur was seen lying against the ilium higher than the acetabulum, and a little behind it.

In other words, the patient had had a coxitis in January, 1910, followed by articular ankylosis. This had been the cause of her pain, her unwillingness to move, and her nervous pertur-

bation. The manipulations made by my predecessor had ruptured the adhesions, and then a reversed or everted dorsal dislocation had occurred. A more intimate knowledge of the previous history of the patient, obtained during her stay in the hospital, disclosed the fact that there had existed a vaginal discharge just previous to the attack of so-called rheumatism of the hip. Whether the arthritis of the hip was traumatic or infectious is unknown.

In order to reach an operative conclusion, which would give the patient the best use of the injured limb, I called into consultation Dr. James P. Hutchinson, Dr. J. Torrance Rugh, a surgeon and the orthopedist respectively of the hospital, and Dr. Oscar H. Allis, who has made such a valuable study of dislocations of the hip.

The question submitted was whether attempts should be made to reduce the luxation rather than excise at once the head of the femur and thus establish a movable hip-joint.

The acetabulum after the lapse of about five weeks was presumably well clogged with remains of capsule and with inflammatory exudate. It was known to have been an abnormal joint before the luxation took place. The attempts at reducing the displacement by my predecessor were apparently successful but he was unable to keep the head in the socket, and suspected that the acetabular rim had been broken off. If a stiff hip occurred after a successful replacement, the patient would lose either the ability to flex the hip, as in sitting, or the power to straighten it, as in standing. The joint would be fixed in a position favorable for only one posture, and the patient would be unable to assume the other. My own feeling at first was that reduction should be attempted; but after hearing the opinion of my associates, and considering the history, I decided that it would be wiser to excise the head of the femur and establish a movable joint.

On November 29, 1910, therefore, I made a long incision behind the great trochanter and found the head lying on the ilium considerably above and a short distance behind the

acetabulum. It rested in a socket-like depression caused by the normal concavity of the bone at that site being deepened by inflammatory thickening of the surrounding soft tissues. The acetabulum was readily identified. It was situated about one and one-half inches below and a little in front of the resting place of the femoral head. It was filled with soft structures, through which the socket could be felt with the finger tip. The head of the femur was removed by dividing the neck close to it; and the wound was closed with sutures, after a drainage tube had been introduced. A gypsum encasement, including the pelvis, hip, and thigh, was applied, with the limb extended and slightly everted. Traction on the leg was made by Buck's method with about twenty pounds attached to the stirrup. An opening was left in the gypsum splint for dressing the wound.

The drainage tube was removed early, the canal left by its withdrawal loosely packed with gauze, and the encasement removed permanently in less than three weeks. Massage and passive motions of the knee and hip were ordered on the twenty-second day; the patient got out of bed on the twenty-fourth day, and was directed to sit up in a chair and gradually increase the flexion of the hip.

She continued to be very much afraid to use the limb or try to walk, and said that she had not been out of bed for a year; but at the end of a month she was walking a little on crutches, and the knee, though still stiff from long disuse, was gaining normal mobility under manipulation. The wound had healed promptly except that a sinus existed at the point where the drainage tube was employed. Flexion and rotation of the hip were quite good.

She was ordered to wear a shoe with a high heel and sole, and as rapidly as possible to dispense with crutches or cane. She was unwilling to obtain the shoe before leaving the hospital. Since she went home, I have not seen her. A letter recently received shows that she has not obeyed orders in regard to using the limb actively. I therefore fear that she will not obtain as satisfactory a hip-joint as she otherwise would.

This case is reported to the Association because of the infrequency of reversed, or everted, dorsal dislocations of the femur, and because my ignorance of the condition led me to believe at first that I had an old fracture of the neck of the bone before me.

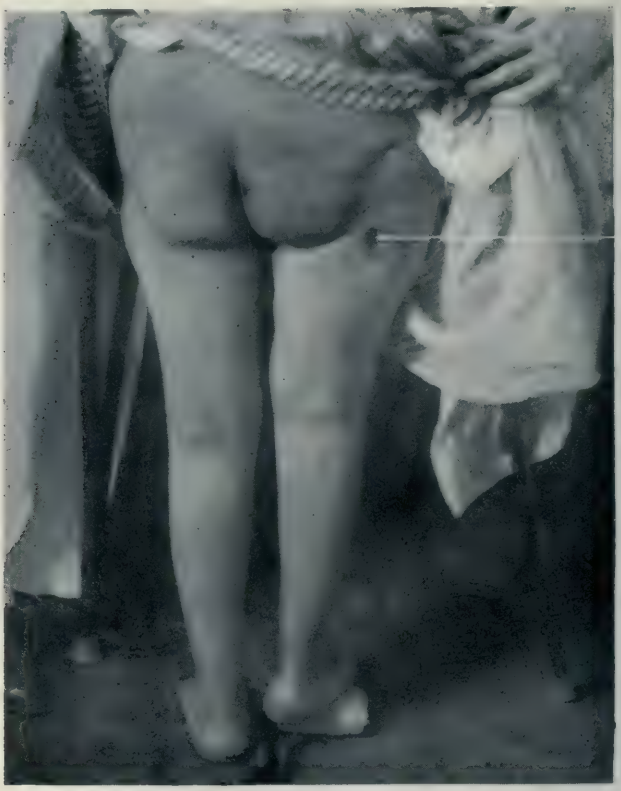

FIG. 5.—Posterior view after excision of the head of the femur, showing shortening of the limb and the point of exit of the drainage tube. Taken about a month after operation.

It is a good illustration also of the value of *x*-ray pictures. These should always be studied by the surgeon himself, with, however, the aid of an experienced radiologist. I find it of the greatest importance to see and study the plates myself. Errors

are likely to be made if the surgeon merely reads the report of the person who made the skiagraphic picture.

In the instance before us the verbal report made to me by the Resident Surgeon of the hospital was that the first skiagraph

FIG. 6.—View to show the amount of flexion of hip and knee possible about a month after resection of the head of the femur for supracotyloid dislocation of the right hip. The patient is sitting in an ordinary wooden chair. The knee is stiff from long retention of patient in bed before the dislocation occurred.

showed a normal joint. This was found to be an erroneous statement, because inspection of the plate revealed arthritic changes. I have long regretted that I am not a skilled micros-

copist and a practical radiologist, in order to more properly gauge the value of my surgical diagnoses.

In 1892 Dr. L. A. Stimson reported to this Association an interesting case of upward luxation of the hip, which this case of mine resembles, and in the TRANSACTIONS of 1900 is given the account of Dr. Oscar H. Allis' valuable demonstrations of dislocations of the hip, made before the Fellows at the meeting of that year. Ridlon has reported a supracotyloid dislocation, and adds a valuable bibliography. He gives what I think is a valuable hint. It is that the steady pelvis, necessary when reducing luxations of the hip, may be obtained by flexing the uninjured thigh strongly against the trunk of the patient and strapping it there. The operator's assistants then have a grasp and a leverage by which the pelvis can be held practically immovable, during such manipulations as may be required, without fastening the patient to the floor with apparatus.

It is now believed generally, I think, that leverage during flexion of the hip is the usual mechanism of luxations of the head of the femur. The femoral head probably escapes always downward by bursting the joint capsule, by means of pressure against its internal surface. Displacements then occur in various directions from the continuance of the accidental forces or as a result of incidental forces. The head of the bone may finally come to rest at any point around the socket. The capsule may be torn from the edge of the acetabulum, from the upper end of the femur, or between these two points. There are two usual positions on the anterior plane of the pelvis, and two on the posterior plane, which have received the names thyroid and pubic, and iliac and sciatic respectively. Greater laceration of the capsule, especially of its iliofemoral reinforcement, termed the inverted Y-ligament, permits wider excursion of the head under displacing factors. As a consequence various modifications of the posterior and anterior dislocations may occur. Their names are numerous, but the necessity of specific nomenclature is not very apparent.

The capsule is not infrequently crowded into the acetabulum

by the advancing head of the femur during attempts at reduction. This is most likely to occur when the course of the head, in its exit from the socket, is not retraced by it, when the surgeon essays replacement.

The reversed dorsal luxation, seen in these photographs and skiagraphs, is simply a modification of the ordinary high dorsal displacement, permitted, it is believed, by inclusion of the external limb of the iliofemoral ligament in the capsular rupture. It is said by König to occur in breaking away of the posterior wall of the acetabulum. It is more or less equivalent to the so-called "supracotyloid" or "subspinous" form. It is not unlikely that "supraspinous" is employed for a modification of the same form of displacement, for it is described as having the head resting on the ilium much in advance of its usual luxated position and lying above the anterior inferior spinous process or even in front of it, so that the neck of the bone rests against the notch between the anterior superior and anterior inferior processes.

In the ordinary dorsal luxation, usually termed the iliac dislocation, the head of the thigh bone lies much behind and above the socket. Because of the tension of the untorn outer branch of the iliofemoral ligament the limb is inverted. The hip-joint is flexed. When the external limb of the ligament is torn, however, the head of the bone is free to move forward under appropriate forces. Then it approaches the region above the acetabulum and the anterior inferior spine of the ilium, and becomes a reversed or everted dorsal, a supracotyloid or a subspinous. Perhaps the so-called "supraspinous" may be a mere variation.

In reviewing this case I have criticised myself for not removing the whole length of the neck of the femur when I excised the head. I have wondered whether a better use of the limb would have been obtainable by scooping the soft tissues out of the socket, turning in a flap of fascia, and then reducing the luxated head instead of excising it. Discussion of these points would greatly interest me.

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DISCUSSION.

Dr. George W. Crile, Cleveland.

I wish to mention a physiological method of reduction of the hip. The principal resistance to the reduction of dislocations is the normal muscular tone and the muscular contraction due to the mechanical stimulation of the muscles in the course of the efforts at reduction. These two principal obstacles in the way of a reduction may readily be overcome as follows:

If the patient is anesthetized with ether down to the level of ordinary surgical anesthesia this method will not apply, but if the anesthesia is continued until all the deep and superficial tendon reflexes are lost, until normal muscular tone is lost, until one may tap sharply the abdominal muscles with the finger without muscular reaction, usually requiring ten minutes of ether anesthesia, the bone then may be gently replaced into position with but a minimum mechanical force.

Mr. Harold J. Stiles, Edinburgh.

Dr. Roberts, I believe, said that, having failed to reduce the dislocation, he removed the head and neck of the femur. If I understood him rightly, he censured himself for removing the whole of the neck as well as the head. It seems to me that if you have a dislocation of the hip-joint which you cannot reduce, be it congenital or acquired, the best thing to do is to remove the whole neck as well as the head of the femur, otherwise you will get an unstable joint afterward. The neck of the bone will slide upward more and more and you will get considerable shortening, whereas if you remove the whole of the neck and then round off the trochanter and place it in the acetabulum, and put the limb in the somewhat abducted position, you will get a certain amount of stiffness, but a stable limb. The shortening will be compensated for by the abducted position. That is what I have done once or twice in aggravated unilateral congenital dislocations of the hip where I failed to get the bone into position.

Dr. Roberts. Is not the plan suggested by Dr. Crile what most of us attempt to do with all dislocations; namely, get the patient sufficiently etherized to enable us to make the proper manipulations without encountering spasm or resistance from muscles, due to their tone or from the patient's fear of pain? One may often reduce a dislocation by surprising the patient, as well as the muscles, without employing an anesthetic.

I have not seen a great many dislocations of the hip, but those which I have seen have usually been reduced by ordinary manipulations under ether. Perhaps Dr. Crile means that we sometimes etherize the patient too much, instead of just up to the point of getting rid of the tonic contraction of the muscles.

I am extremely obliged to Mr. Stiles for his remarks, for he has convinced me that I could have bettered my procedure. At the time of operation I wondered whether or not to saw off only the head of the femur, and finally decided to do this. Later, when speaking to Dr. Allis about the operation, he asked why I had not cut off the whole neck too, for he recognized, as Mr. Stiles has shown, how much more useful a joint could thus be obtained.

AN IMPROVED TECHNIQUE IN BRAIN SURGERY.

GLASS TUBES VERSUS GOLD OR PLATINUM FOR SUBDURAL DRAINAGE OF THE LATERAL VENTRICLES IN INTERNAL HYDROCEPHALUS.

By E. WYLLYS ANDREWS, M.D.,
CHICAGO.

Acquired hydrocephalus is probably in most cases due to various causes—a tumor, a posterior basilar meningitis, or an ependymal inflammation, sometimes to inflammatory action in the basilar vein and stasis. It is certainly at times a posterior basilar meningitis producing obstruction to the foramina of Luschka, Magendie, and Sylvius, and these conditions produce a class of cases which may become surgical. They are, as a rule, met with in early life and, therefore, are somewhat alike in type to the congenital hydrocephalus cases, either external or internal. Early in life they can expand the skull as congenital hydrocephalus will. The sutures may not be so united that the skull will not enlarge, which was the case with the patient I want to show you this evening.

The possibility of surgical interference for the relief of acquired, obstructive hydrocephalus may depend upon finding a removable cause of the obstruction. We may have a cyst in the cerebellum. There are a few cases of tumors involving the cerebellopontine angle which produce internal hydrocephalus, and if we tap the cyst or extirpate the tumor, or if we make a decompression operation, we may relieve the hydrocephalus temporarily, but, mechanically speaking, if the original cause cannot be removed the way to help the obstruction of acquired hydrocephalus of the internal variety is to establish drainage or

to tap the ventricles. Repeated tapping of the ventricles can be done through a fontanelle that is not yet united, or even by draining the spinal canal by lumbar puncture, a method which some neurologists have condemned. As far back as 1888 or 1889 I remember seeing some operative work attempted in von Bergmann's clinic in this line. Von Bergmann, and I think Kocher and one or two others, made a consistent effort to relieve by operation cases of posterior basilar meningitis with resulting obstruction of the foramina and the slow dilatation and enlargement of the internal hydrocephalus. Cheyne, Ballance and others later improved the technique and reported a few successful cases. We may ask the question, What mechanical relief can be given to this mechanical disorder? Is there a surgical possibility of doing it; and if so, how can it be maintained? Tapping of the ventricles is one thing, and permanent drainage is another. There is no question but that repeated tapping of the lateral ventricle or the fourth ventricle from the occipital region is occasionally curative. Repeated tapping ends somehow in cessation of the secretion. Probably there are some of these dilated ventricles in which the Pacchionian bodies do their work, that is, they absorb a certain amount of the cerebrospinal fluid. In others little artificial foramina are discovered to be formed through the thinned-out wall of the brain substance communicating between the lateral ventricles near the posterior horn or near the third or fourth ventricle. If we can interfere by opening the skull and reproducing the condition sometimes spontaneously produced, as Von Bergmann attempted nearly twenty years ago, we would have an ideal operation. The matter can be reached in more ways than I thought at first was possible. The patient I show you has had two radically different operations done upon him so long as ten years apart, and both of them were successful.

In any technique it is essential to know the easiest way to reach the ventricles. In the ordinary case of internal hydrocephalus the choice would be either gaining access to one or both lateral ventricles, or to the fourth ventricle. I think the operation of opening the fourth ventricle for permanent drainage is the Parkins operation; it is so called by Ballance and some

others, and I know of no one besides Parkins who has claimed priority. It consists in making an incision somewhat similar to what Cushing calls the "crossbow" incision, a horseshoe bisected. We open below the tentorium upon the cerebellum. In a dilated condition of the fourth ventricle, if the foramen of Sylvius is open, draining the fourth ventricle will likewise drain the whole tract. It is easy with a dilated fourth ventricle to find it by displacing a little brain substance. Opening the fourth ventricle is an operation, which, though more difficult in the normal subject, becomes easy in the hydrocephalus subject. This operation was performed upon my patient by Dr. Murphy about ten years before the operation I am about to describe.

What should be our technique if we desire temporarily or permanently to tap the lateral ventricle? There are only two practical routes to the lateral ventricle. Those are the routes used respectively by Keen and by Kocher. I must remind you of some points in cerebral localization. The mnemonics of the thing is easy.

1. Keen's method. To locate the point of tapping the ventricle all that is necessary is to measure 3 cm. upward and 3 cm. backward from the meatus auditorius externally. The lateral ventricle is a fairly large cavity. If we put a needle through the brain substance (at the place I have spoken of, as worked out by Keen) and pass it inward and slightly upward, we will reach the lateral ventricle in a normal subject. We have seen that repeatedly in brain abscess invading these cavities. In a case of internal hydrocephalus it is so large as to make its discovery by aspirating very easy.

2. Kocher's method. With regard to the Kocher incision, it is made at a spot at the right or left $2\frac{1}{2}$ cm. from the middle line, and 3 cm. in front of the coronal suture. If the head be shaved and one can feel the sutures, then the bregma will be a little behind that spot. That practically covers the whole subject of finding the ventricle. But what further are you going to do if we tap and drain the dilated ventricle? We should try to create a permanent drain, to drain this distended cavity into some absorbing cavity. Several times we made an attempt with the von Bergmann method to do this by carrying a drainage

appliance to one layer or the other outside. The first case of this I ever saw attempted was in our own city in the hands of Dr. L. L. McArthur, fifteen years ago at the Michael Reese Hospital. He had two cases, one of them completely successful, although I am not sure whether permanent or not. He drilled a moderate sized hole in the region above where I spoke of as Keen's line

FIG. 1.—Appearance of scar after first operation on the fourth ventricle.

of opening. He passed a gold or iridioplatinum small tube with a flange into the lateral ventricle. He then closed the tube underneath the scalp tissue. The effect of this, if it is not obstructed by coagula, is to cause permanent slight leakage into this tissue, causing a cerebrospinal edema of some small spot which will turn the balance of absorption so as to make it equal the secretion. This technique was not always successful in

permanency of result. Watson, Cheyne, Ballance and some others tried a different technique. Their method consisted in inserting an iridioplatinum or gold tube, which is as little corrosive and as little irritating as any metal, into the lateral ventricle and carrying its outer end only as far as the subarach-

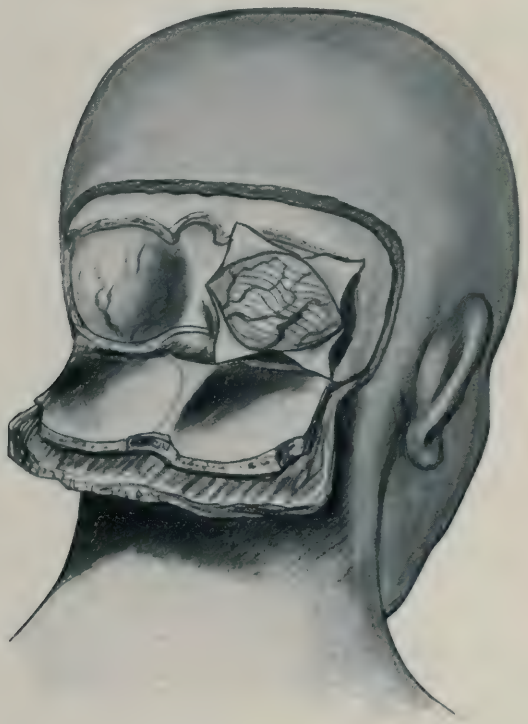

FIG. 2.—Method of exposure of cerebellum and fourth ventricle.

noid space. In some cases the end has been turned at a right angle, and in some others flanged, the dura mater being sutured over the tube.

Fig. 5 represents accurately the operation which was performed on the patient here reported. The lateral ventricle is drained by the tube, which you see passing through the convolutions, and over it has been sutured the dura. The trephine opening in the

skull is here represented as not being filled. The pericranium with the hairy scalp is sewed over that, the drainage being secured permanently across into the arachnoid space. An effort was made by a draughtsman, at my suggestion, to make this picture (before I had a skiagram). My memory as to the size and form of the tube was correct. There is a striking resemblance between the drawing and the form and position, as shown by the skiagram which Dr. O'Donnell was successful in making for me, some three years after it was put in the brain tissue.

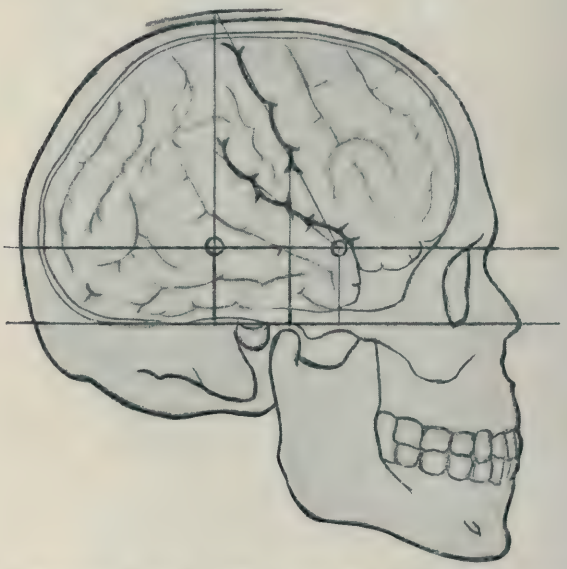

FIG. 3.—Base line through lower margin of orbit and external meatus. Parallel line through upper margin of orbit perpendicular from middle of zygoma and mastoid process. Angular lines from these landmarks locate fissures of Rolando and Sylvius.

I will now give the history of this case:

The patient, a young man, had fairly good health in childhood, but at the age of twelve years he was under the care of Dr. J. B. Murphy for obstructive chronic internal hydrocephalus. The patient's head was $20\frac{1}{2}$ inches in circumference. We probably lack an accurate account of when the head began to enlarge. He had severe headaches. These attacks recurred at intervals

of six months, and lasted from three to six weeks. The size of the head increased constantly during three years. I suppose the sutures began to separate before the age of consolidation, and perhaps have kept on separating. The patient was then and is now totally blind. Loss of sight came on for obvious reasons under great pressure. He had choked disk and papillitis and complete optic atrophy. He had been blind since 1897. He was as strong and bright as other children until the attack for which Dr. Murphy treated him.

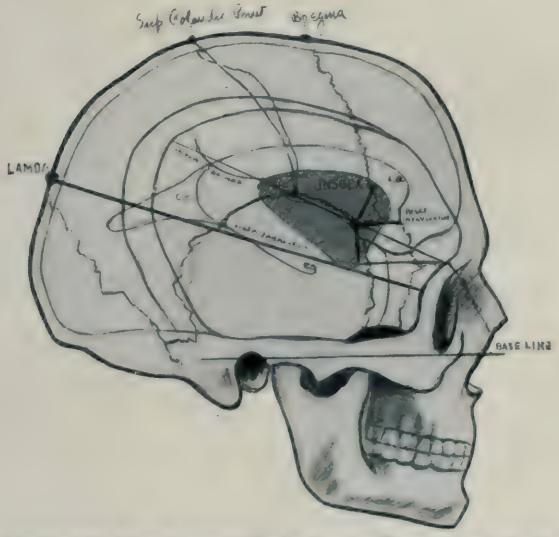

FIG. 4.—Outline of lateral ventricle to locate Keen's and Park's points of tapping.

The operation which was done at that crisis was as follows: May 10, 1897, a horseshoe-shaped opening was made down over the occipital bone to the right of the median line. A flap was laid back. Bleeding was profuse and was stopped by packing the bony foramina; as soon as the dura mater was opened there was a gush of cerebrospinal fluid. The operator found the dilated ventricle by slightly pushing aside the cerebellum by gentle, blunt dissection. There was a sort of cystic distended sac, which was the fourth ventricle. The velum was seen bulging

up. It was opened into and the fluid escaped more profusely. A few silkworm-gut strands were placed in as a drain, the soft part stitched over this, but the button of bone was not replaced, and the gauze which had been temporarily pushed in the foramen

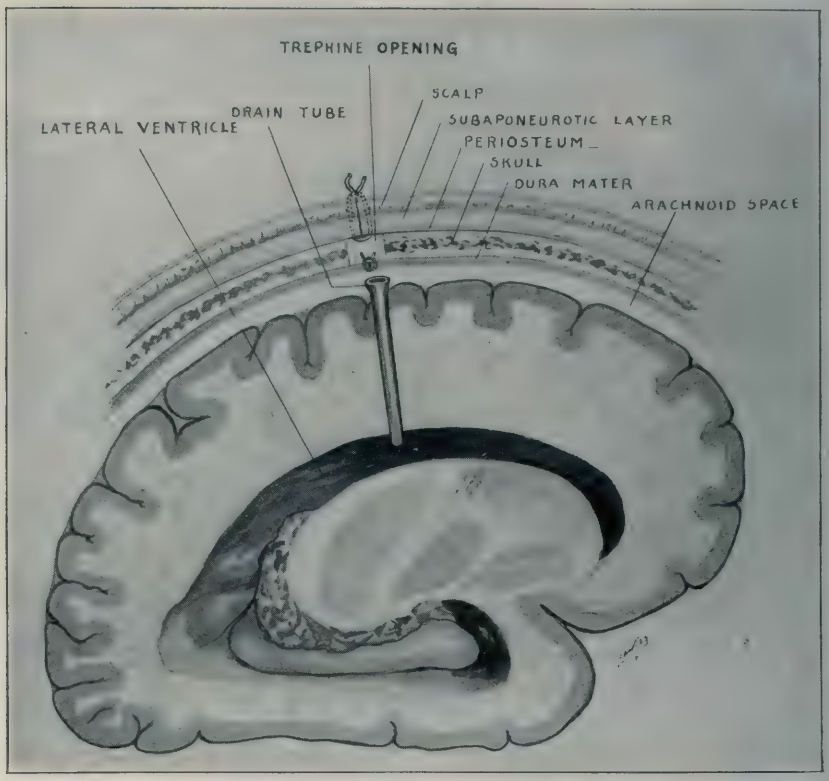

FIG. 5.—Diagram of transverse section of brain and skull at level of lateral ventricle. The glass tube is shown in place connecting the ventricle to the subdural space. Compare this drawing, made from memory after three years, with the skiagram (Fig. 6) made at the same date.

to stop the gushing was drawn out after the wound was nearly sutured. That was done on May 12, 1897, and on the 18th all stitches were removed. The patient was then cured. He recovered from his semicomatose condition, but he did not regain his vision. He went along from 1897 to 1906, when he had return

of pressure phenomena and was under the care of Dr. Archibald Church, and from June 12, 1906, until about July 26, Dr.

FIG. 6.—Skiagram of glass tube in lateral ventricle. Anteroposterior operation June 26, 1906. Skiagram taken July, 1909.

Church had him under constant watch. At that time he was relapsing. He began to be delirious, and was later semicomatose.

He had some paresis. Later there was constant delirium and mania. According to the history, his pulse was somewhat slow. Pressure disturbances went on from bad to worse. Finally, the case was so desperate that he could not be kept in an ordinary

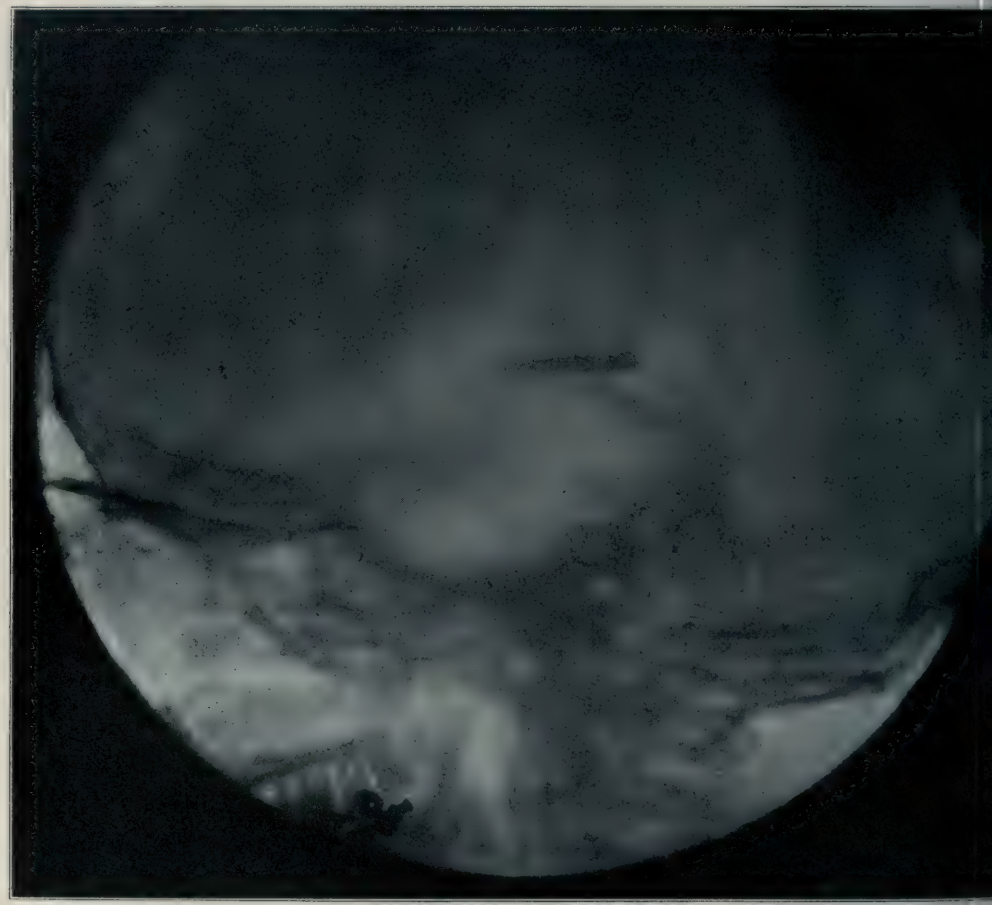

FIG. 7.—Lateral view, showing tube foreshortened.

hospital, and Dr. Church proposed surgical interference. I examined the case at some length, and concluded that I would not be able to repeat the operation posteriorly, the Parkins, on the fourth ventricle, but decided to attempt a permanent

drainage of the lateral ventricles. When examined first by me his head measured $22\frac{1}{2}$ cm. in the frontal diameter; the occipito-bregmatic diameter was $17\frac{1}{2}$ cm.; the bitemporal, 15 cm.; biparietal, 17 cm.; and the circumference of his head at that time was $26\frac{3}{8}$ inches. It was stated in the history that he was better for a number of years after his first operation; then he began to act strangely. He would cry and laugh and become delirious, and finally became comatose, so that all the symptoms became more profound and alarming. I aspirated the lumbar spine and withdrew 16 c.c. of spinal fluid, which was perfectly sterile and clear, and no culture was found in any medium, nor was there any microörganism found in the sediment removed centrifuged. When I planned this method of operation I thought I would open successively upon the two sides, first upon one lateral ventricle, and then upon the other. But there was more paresis on one side than upon the other, which led me to select the left side.

Second operation, June 26, 1906. An incision was made essentially over Keen's point. If we measure 3 cm. up and 3 cm. back and remove a button of bone we have practically done what I did here. Dr. Church was present at the operation, and coached me in what to do as well as what not to do, and among other things which his coaching included was not to withdraw too much cerebrospinal fluid. I could have withdrawn easily 500 c.c. He believed that it was a wrong practice to withdraw much at first, and, guided by his wishes, I withdrew as little as possible. I had prepared some years before, for such cases, two gold tubes, which an instrument maker made for me, with small flanges, one of them $1\frac{1}{2}$ inches in length, and the other about $1\frac{3}{4}$ inches. The patient's head was unusually large, and at the last moment I thought I would have another longer tube. I made then a glass one by cutting off a piece of a female catheter, $2\frac{1}{2}$ inches long, flanged at one end. Had I not had this with me I should have failed in the operation. The tubes of the length recommended by some writers were entirely too short for this case. The aspirator entered more than 2 inches through brain tissue before it reached the ventricle, either because I did not reach the thinnest place or passed the aspirator too obliquely, or because the brain

tissue was too thick. In tapping the ventricle always thrust the needle point through brain tissue, the gray and white matter, not through the sulci. We must not wound the ganglia at the base of the brain, nor the vessels which are in the sulci between the convolutions, but pass the needle through the brain tissue. In aspirating the ventricle one should use a blunt-pointed cannula with a guide. In employing the scoop-shaped hollow needle point, it will take out a little plug and cork itself up at the end. In this case I got a very free gush of cerebrospinal fluid. Now appeared the value of the extra long tube. This was the only one which would reach the ventricle, and continue to drain—namely, the glass one, prepared as just stated on the bare chance of needing it. I do not know of any other instance of glass being used instead of gold and platinum. It is possible that the material is better. From our observations of the use of glass tubes in the abdominal cavity we know that they will drain for three or four weeks quite freely, whereas rubber or metal tubes become blocked with lymph in several days. The operation consisted of inserting a tube with its flanged outer end just in the subdural space and closing the dura outside of it, then closing the pericranium and scalp in the simplest possible way. The result of this was a complete cure. The coma and delirium were relieved after a few days. The patient was lifted out of his tragic condition and has remained well up to the present time, nearly five years after.

I am convinced that the use of a thin glass, rather than metal, tube contributed not a little to the success of this interference. The smoother surface texture of glass and the light specific gravity probably contribute to this result. The plate shown in Figs. 6 and 7, taken three years after the operation, show the tube to have remained exactly where inserted, and the permanent cure speaks for its persistent utility.

DISCUSSION.

Dr. Lewis L. McArthur, Chicago.

I feel that I have somewhat the priority in this method of drainage mentioned by Dr. Andrews. Some eighteen years ago Dr. McBurney, in writing on this subject, reported his efforts in draining outside the body upon aseptic gauze for the purpose of relieving an internal hydrocephalus, and found in those cases in which he made this effort that the longest time which he could maintain an aseptic condition of the wound was seventeen weeks. The idea came to me, after reading his article, that if instead of draining upon the surface of the body I drained the ventricle through the bony vault beneath the scalp into the cellular tissue, I would be enabled to secure a permanent drainage. This idea being presented to my colleague, Dr. Church, of the neurological department in our hospital, when a suitable case arrived he turned it over to me. In the meantime I had sought among the instrument makers for a bit of tubing to be utilized, and found in the veterinary department a very small silver cannula with a flange used for the purpose of milking cows. This cannula having a small flange and a small tube enabled me to pass it into the ventricle through a small drill hole situated beneath the midpoint of a hemispherical scalp wound. The flange prevented its dropping into the skull and also its coming out. The lumen of the tube I plugged with some strands of catgut for the purpose of preventing the immediate escape of the fluid, in order that I might get a primary union of my scalp wound. The operation was successful. I secured a primary union, and the child, from being a nervous, irritable, crying child, became one that could play with its comrades and run on the streets. It lived for three years, finally dying of intestinal trouble during hot weather. Two other cases I have operated upon in a similar manner.

I believe that the aim of Ballance and Andrews is to drain the fluid through the cerebral substance into the pia and subarachnoid spaces. That proving efficacious, it appears to me the simpler drainage of the ventricles is made after the method above described by a small drill hole in a proper position, passing a twisted silkworm-gut strand into the ventricle and attaching it to the external periosteum. This permits the fluids to escape along its entire course into the subarachnoid and into the scalp. This was efficacious in one case, one-half of the head remaining small, although the other continued to grow. The parents refused to have an operation on the other side of the head. A third case operated on during the Congress held in Chicago some

months ago recovered from the operative interference, showed the usual edema of the scalp that accompanies efficient drainage with silkworm-gut, but having at the time of operation a leaking spina bifida, went off with a septic spinal meningitis five weeks afterward.

Dr. George E. Brewer, New York City.

In regard to the evolution of this operation I could report two or three fatal cases, but it might illustrate the fact that the sequence of events was rather progressive. In 1898, at the Mt. Sinai Hospital, we had a case of hydrocephalus in a very young child, aged about six months, and by advice of Dr. F. Petersen, I attempted to drain the ventricle into the subdural space by the method of making a flap in the back of the head and exposing the posterior lobes above the tentorium, raising the posterior lobe on one side where the ventricle is close to the surface and no important structures to be injured. Then, by a puncture into the lateral ventricle I introduced a small filament of rubber tissue, folded to make a number of strands, forming a small flange-like drain, so that the flanged surface lay on the tentorium and the perpendicular portion entered the cavity of the lateral ventricle. Although this child was greatly shocked, it recovered from the operation, but lived only six or seven weeks. During that time we kept up pressure on the outside of the skull by a rubber bandage, and the head diminished a good deal and the symptoms certainly were no worse. Although the child afterward died from an intestinal affection, I thought it a reasonable method of drainage. I tried it in two or three other cases, with fatal results. My colleague, Dr. J. A. Blake, then tried using silver tubes with a flange, entering from the tentorial surface of the posterior lobe, but I have had no further experience with these cases, as my disasters have led me to hesitate to institute drainage. I believe, however, that any method which will allow the fluid to pass from the ventricles into the subdural space is likely to prove of benefit.

Dr. Joseph Ransohoff, Cincinnati.

We are fortunate in having with us Mr. Stiles, for he can tell us about the tying of the common carotid arteries in these cases.

After hearing of Mr. Stiles' work in this direction I tied the common carotid arteries in two children, with unexpected results. An adult with a normal brain would probably have died. I do not see the reason for draining the ventricles by leaving a tube in the interior. Possibly some of you are not familiar with Brown's method. We have the roof of the lateral ventricle formed by a useless structure, the corpus callosum. In all of these cases of distention of the lateral ventricle

the corpus callosum is very thin, and it is a simple matter to make a drill hole near the median line and through it pare off the corpus callosum, and thus establish efficient and permanent drainage without leaving anything in the interior to give rise to trouble later.

Dr. Charles H. Frazier, Philadelphia.

In a case of hydrocephalus which I had under my observation for a number of months I was persuaded to try a method advocated by our guest, Mr. Harold Stiles. In a visit to his clinic in July, 1910, he told me of his results by ligation of the common carotid arteries. Six weeks after ligation of one common carotid, I proceeded to close the remaining artery, but fearing vascular or nutritional disturbances of the brain tissue, I decided to close the artery with a platinum clamp instead of a ligature, so that in the event of any serious consequences the clamp could be removed and the circulation restored.

The common carotid was exposed, the clamp applied and with a pair of forceps pressed very gradually and gently together until the blood stream was entirely interrupted. The wound was closed with the clamp *in situ*. There were no signs of any brain anemia until the fifth day after the operation, when the child developed weakness in the left arm and leg on the opposite side. On the following, that is the sixth day after the first operation, I reopened the wound, gradually opened the clamp, and found that the lumen of the vessel was still preserved and the blood stream unimpeded. I decided again to compress the vessel, but not sufficiently to obliterate completely the lumen, thus allowing a small quantity of blood to pass the clamp. In the course of a few days the weakness of the arm and leg disappeared. Two weeks later I opened the wound again, and upon removing the clamp found the vessel lumen still patulous and blood flowing past the clamp. A permanent ligature was then applied. The last operation was performed only ten days ago, and at that time the child's condition was satisfactory; there was no evidence of any return of intracranial tension.

The immediate effect of the operation upon the intracranial tension was striking. The exophthalmos disappeared, and instead of protrusion there was marked depression at the fontanelles. A lumbar puncture showed that the cerebrospinal fluid was not excessive or under very great tension.

Mr. Harold J. Stiles, Edinburgh.

In any discussion on the treatment of hydrocephalus I think we must make it absolutely clear that in congenital hydrocephalus there is no blocking of the passages at the fourth ventricle; indeed, the

foramina in the roof of the fourth ventricle are much larger than normal. That being the case, I do not think you can expect any form of drainage to do good in congenital hydrocephalus. I have tried all kinds of methods of drainage from the ventricular system into the subdural space, also drainage from the spinal canal into the abdomen, but I never got anything but temporary benefit from these methods.

In congenital hydrocephalus there is a disturbance between the balance which should normally exist between the secretion and the absorption of the cerebrospinal fluid. The indication is to diminish the secretion by ligaturing the common carotids, the one a fortnight after the other. My first patient, operated on five or six years ago, is now perfectly well. My second cure was a twin, and the mother tells me that whenever the twins contract any of the prevalent diseases the one who had the hydrocephalus always makes the more rapid recovery.

The operation should be done early in the disease. I have never found it do any good when the hydrocephalus is associated with spina bifida.

In acquired hydrocephalus the indication is to drain the ventricle, because these forms are due to obstruction.

A STUDY OF THE INFECTIONS.

By ALGERNON T. BRISTOW, M.D.,
BROOKLYN, NEW YORK.

Hospital laboratories have for many years devoted their energies to the study of morbid tissues, but only occasionally to the bacterial origin of the infections. The desultory work which has been done has been in a few large hospitals connected with teaching institutions and a few others with ample means and a large laboratory staff. Thus, the study of infections from the bacteriological standpoint has not received the attention which it deserves. With the discoveries of Sir Almeroth Wright, however, and application of his principles to the creation of an artificial immunity in individual infections, the bacteriology of surgical diseases assumes new significance.

Important as the study of tissues undoubtedly is, particularly from the diagnostic standpoint, the study of the infections assumes at least equal importance, more particularly, however, from the viewpoint of therapeutics which is, after all, the goal of our art. The chief reason for the relative neglect of this important branch of hospital work has been, no doubt, the enormous amount of time which such investigations require. The average hospital pathologist, sometimes paid, more often unpaid, has quite enough to occupy himself with the tedious preparation of morbid tissues for the final judgment of the microscope without dabbling in the mazes of bacteriological work. If this branch of pathology is to receive the attention which its importance deserves, we shall have to add to our hospital staff a paid bacteriologist who shall have nothing else to occupy his

time save the hunting down of infections and the making of vaccines. From the writer's experience of more than three years with vaccines, it is his opinion that Wright's work has added a most valuable weapon to our armamentarium against disease. We have only begun to know how to use bacterial products. We are but on the threshold of our investigations into the problems which are involved in the production of artificial immunity. Antisepsis and asepsis secured us to a wonderful immunity against wound infections following the surgeon's knife. Wright's methods promise us a victory over primary infections against which our only remedies hitherto have been incision, drainage, and the natural resistance of the patient, which has too frequently proved insufficient to the task.

A case of primary infection, which occurred in the writer's service two years ago, emphasized most strongly the prime importance of the fact that in each infection the bacteriological source should be traced. The case has been published in full in the *New York State Journal of Medicine*, but may be briefly referred to here.

In March, 1909, an Italian came into the writer's service at the L. I. C. Hospital with a sinus leading down to some carious bone at the angle of the jaw. No cultures were taken previous to operation and there was nothing to indicate the presence of anything unusual. Operation was done and the carious bone removed. The reaction to operation was somewhat severe, but subsided and subsequently the sinus closed without incident, nor was there ever any serious infection of the face. A week after the operation the man began to complain of atrocious pain in the calves of the legs. Finally it was evident that an abscess had formed in the left calf and it was opened and found to contain grumous, bloody pus. Through the courtesy of the Hoagland Laboratory, cultures from the pus were taken at the time of drainage. Subsequently a similar process occurred in the right forearm. The infecting organism, to the astonishment of everybody concerned, proved to be that of glanders, of which the patient had not a single symptom. There were no farcy buds, no

nasal discharge, nothing save the suppurative processes in the left leg and right arm, and these did not differ from ordinary metastatic foci except in the grumous character of the pus, which, although a feature of the suppuration of glanders, also occurs in other infections, being ordinarily simply an evidence of a low grade of resistance on the part of infected tissues.

Time does not here serve to go into this case at length. It was fully reported in the May, 1910, number of the *New York State Journal of Medicine* by the writer, the laboratory work being described by Dr. Benjamin White, the director of the Hoagland Laboratory. Suffice it to say that the organism gave the Strauss reaction with guinea-pigs and agglutinated known cultures of the Bacilli mallei. An autogenous vaccine was made from the patient's own organism. He recovered after an illness of five months, and when last heard from had remained well. He had worked along shore previous to his illness, but had not been specially in contact with horses. Every effort was made to trace the source of his contagion without success. One thing was certain, he had glanders. This case is mentioned, not only because of the therapeutic success attending treatment, but also because it emphasizes in a particularly striking manner, the necessity and the value of bacteriological work in connection with the infections. Had it not been for the friendly aid of the Hoagland Laboratory this man would have been treated as an ordinary case of metastatic abscess and many persons placed in great danger, since with the possible exception of the bacillus of pest, there is no organism which has claimed so many laboratory victims as the Bacillus mallei. True, we ought always to exercise the greatest precautions in treating all infections, but when the treatment extends over weeks and daily dressings are required, vigilance is too often relaxed with results which are unpleasant with ordinary infections, but which might be deadly with so terrible an infection as that of glanders.

During the fall of 1910 the Directors of the Hoagland Laboratory offered to put at the disposal of the Long Island College

Hospital the services of Mr. H. W. Lyall for bacteriological research into the origin of all surgical infections treated in the hospital. This offer was gladly accepted and the cases here analyzed were those which came under the charge of the writer the past winter, together with a few others from other operators in the hospital. A number of times Mr. Lyall went with the writer to the Kings County Hospital for similar investigations, and a few cases from that hospital are included in this report. The period of observation has been too short and the cases too few yet for our records to be more than suggestive. If attention is called to the great importance of this work so that it becomes a part of the hospital routine, which is not at present the case, the writer will feel that something has been accomplished.

Bacteriological Routine (C. N. Garside, M.D., Hoagland Laboratory).

Collections of Material.

The following rules were observed:

(*a*) Apply no germicides to an open lesion, or if such substances have been applied, wash with sterile water and wait at least two hours before taking specimen.

(*b*) Avoid contamination, either from the person of the operator, instruments and supplies, the patient or his environment.

(*c*) Discard the first or top pus. Take the specimen from the depths of the lesion, thus avoiding dead or attenuated organisms.

(*d*) Make inoculating smears upon the surface of at least two Loeffler blood-serum slants.

(*e*) Avoid exposing the cultured material to extremes of heat or cold and delay in incubating.

(*f*) Make at least two smears upon glass slides and fix by gentle heating.

The only addition to these procedures is in the case of lesions whose cause is known or suspected to be a very delicate organism, *i. e.*, influenza bacillus, gonococcus, etc., when media richer in animal proteid is supplied, such as blood or ascitic agar.

Laboratory Procedure.

When the specimen reaches the laboratory, it goes through the following routine:

(*a*) Stains: Gram's method and with Loeffler's alkaline methylene blue, and in certain cases an acid fast stain. This serves as an inventory and an attempt is made to recover from the plates all organisms thus demonstrated in the exudate.

(*b*) Plates are prepared of suitable media, the usual one glycerin agar. The laboratory custom in plating is the use of the ordinary streak or the Conradi method.

(*c*) Incubation of the plated material at incubator (37.5° C.), and at room temperature.

(*d*) Under certain circumstances, anaërobic conditions are supplied.

(*e*) Study of and fishings from the colonies developed on the plates and isolation in pure culture.

(*f*) Identification of species by the use of differential media, animal inoculation and immunity reactions. Blood cultures are made through an incision of the properly sterilized skin over the median basilic vein. The blood is either immediately placed into the culture medium or first introduced into an isotonic and decalcifying solution. The latter method is used if culture material is not available at the bedside. For inoculation, five cubic centimeters of fluid medium and the remaining five cubic centimeters of blood are distributed in plates. The fluid medium most used is neutral broth. Under certain conditions, dextrose broth, lactose bile, ascitic broth, and neutral broth to which calcium carbonate has been added are used. The plate medium ordinarily used is plain agar to which may be added ascitic fluid or other enriching material.

During the winter there were 108 cases of infection examined for the writer at the Hoagland Laboratory. The cases of ruptured appendix were not here included, some thirty in number, as the resulting cultures were so rich in intestinal flora that conclusions as to the infection were not of much value. Intestinal

or sewage streptococci were quite common. The colon bacillus was invariably found, not often in pure culture. The first place among the flora of the intestine in appendicular infections must always be given to the colon group. It occurred in over 90 per cent. of the cases. After that, to the streptococcus. We know little as yet about the varieties of the streptococci. There is one variety, however, the individual cocci, rather small and clear cut, occurring in chains of five or six members and deeply stained, which is always associated with a virulent infection. Shorter chains of four or five members, the individual cocci rather large, have never been observed as associated with the severe types of inflammation. The 108 cases which we analyzed have been classified according to the infecting organism, and occurred as follows:

Staphylococcus aureus, pure culture	25
Staphylococcus aureus, mixed	18
Streptococcus pyogenes, pure culture	22
Streptococcus pyogenes, mixed	13
Staphylococcus albus, mixed	6
Colon pure (not including appendix cases),	11
Colon, mixed	1
Pneumococcus, pure	11
B. Friedländer, mixed	2
Pyocyaneus, pure	1
Pyocyaneus, mixed	3
Diphtheroid, pure	1
Diphtheroid, mixed	22

The appearance of a bacillus closely resembling the Klebs-Loeffler bacillus so frequently in 22 per cent. of the cases is, perhaps, the most interesting observation in this short series of cases. It occurred once in pure culture in a granulating sinus of the thigh, following an operation for necrosis; twelve times in association with the Staphylococcus aureus; twice with Staphylococcus albus, both times in acne cases; once in conjunction with the Streptococcus pyogenes and aureus; once with Bacillus coli and a sewage streptococcus. It also occurred in the medical wards with mild cases of sore throat not accompanied by exudate nor any serious constitutional disturbances. One case of this class is typical of all, as follows:

J. F., recovering from typhoid fever, complained of sore throat. No exudate. Cultures from swab could not be distinguished from true Klebs-Loeffler bacilli. Neisser granules found. Not pathogenic to animals. Guinèa-pig inoculated intraperitoneally after an interval of two weeks in good health; autopsied; adrenals clear; no adhesions; everything normal. This man was quarantined for two months by the Board of Health. During this interval he had no sore throat. This mild sore throat appeared in five post-typhoidal cases all in the same ward. In no case was the culture to be distinguished from the true Klebs-Loeffler, but it was neither true diphtheria nor a non-virulent diphtheria organism. Occurring in 22 cases of mixed infection, it cannot be said, so far as was known, to have added to the severity of the case. It was most frequently associated with aureus (12 cases), next in frequency with the streptococcus (5 cases). Dr. C. F. Garside of the Hoagland Laboratory writes as follows concerning the classification of this organism:

Pseudodiphtheria Organisms.

The following tentative classification of the diphtheria and diphtheria-like organisms has been adopted by the laboratory:

1. True, virulent Klebs-Loeffler bacilli.
2. Avirulent Klebs-Loeffler bacilli.
3. Hofmann's pseudodiphtheria bacillus.
4. Bacillus xerosis.
5. Diphtheroids: Organisms which resemble the true diphtheria bacillus in the following essential features—Gram positive, non-motile, non-sporulating bacilli, which show a parallelism in their arrangement in smeared preparations and which fail to take the alkaline methylene blue stain in one or more areas of their protoplasm, *i. e.*, beading or barring. These organisms differ from types 3 and 4 in their sugar reactions. Diphtheroids may be divided into the virulent and avirulent. The methods used for differentiating these classes are (1) pathogenicity to guinea-pigs, and (2) fermentative reactions upon various sugars.

1. Animal pathogenicity: The avirulent Klebs-Loeffler bacillus can be differentiated from the avirulent diphtheria-like organism by its reaction on carbohydrates, notably its ability to ferment dextrin. The virulent true Klebs-Loeffler bacillus can be separated from the virulent diphtheroids by animal inoculation, first protecting the experimental animal by immunizing it with diphtheria antitoxin, or by mixing the inoculating dose with diphtheria antitoxin. In either case the animal will survive inoculation with diphtheria bacilli, but will not be protected from the virulent diphtheria-like bacilli.

2. Fermentative reactions: Under ideal conditions, distinct differences are brought out by this method, but certain variations in the reactions of the same strains, because of varied conditions, little understood and difficult to control, have cast some doubt upon the advisability of accepting such evidence as final. Consequently we rely solely upon the evidence supplied by animal inoculation for a differentiation between the true Klebs-Loeffler bacillus and its allied forms. For the present, the classification of the diphtheria-like organisms and the avirulent true Klebs-Loeffler bacillus is based on their fermentative reactions and their cultural characteristics.

The importance of making the distinction between true Klebs-Loeffler bacilli and the diphtheroid group cannot be overestimated. A hospital staff could easily get panic-stricken if the diphtheroids were not differentiated as indicated. In the absence of the clinical signs of diphtheria it is evident that the ordinary Board of Health methods will not avail, nor is the presence of the Neisser granules, sometimes considered pathognomonic, at all conclusive. The only trustworthy methods of differentiation are the behavior of the two organisms with the sugars, plus animal inoculation.

Four of the post-typhoid cases having diphtheroids in the throat were isolated and given special nurses also isolated, for long periods of time; far longer than was necessary to determine the exact nature of the organism. The hospital and Boards of Health must always err on the safe side. At the same time we

ought to recognize the fact that diphtheroids do exist which are non-pathogenic, and so far as known without influence on wounds. The single case in which a pure culture of diphtheroid was isolated from a granulating sinus recovered without any untoward symptom. Further observations on the behavior of this organism in wounds and its influence thereon are most desirable.

The number of closed infections with pure cultures of aureus, streptococcus, pneumococcus, and colon bacillus, was of great interest. It was impossible to trace the path of the infection in any of the cases as they were all seen late in the course of the affection when a definite abscess had developed and it was not possible to discover the origin, whether hematogenetic or by the lymphatic paths from the mouth, tonsil, or intestinal tract.

The following cases of aureus infection were not preceded by abrasion or wound: From a subdiaphragmatic abscess, a pure culture of aureus was obtained. No history of ulcer of the stomach obtainable; no pleurisy. Six cases of prepatellar bursitis were treated and cultured. Like the carbuncles of the neck, of which there were five, from all a pure culture of aureus was obtained. One of the cases of prepatellar bursitis was opened early before sinus formation. The swelling was of two weeks' standing. There was no abrasion of the skin. Pure aureus was obtained from the abscess cavity when opened. A case of osteomyelitis of the lower end of the tibia in a child, aged twelve years, of unhealthy appearance, had been preceded by several aggravated furuncles of the face. Cultures obtained from the bone abscess when opened proved to be aureus. The furuncles had healed at this time and could not be cultured. Many cases of osteomyelitis are said to be preceded by tonsillitis. It is evident that in all these cases of osteomyelitis the infection must be by the blood stream, and not against the lymphatic current by way of the lymphatics. A second case of osteomyelitis, a Brodie's abscess, was as follows:

A young woman, aged twenty-five years, domestic, came under the writer's care suffering from pains in the lower portion of the

left tibia and a temperature range of 100° to 102°. Eight years previous she had suffered from an osteomyelitis of the same tibia, which had been operated. After recovery the intervening years had been free from incident illness until two weeks before writer saw her. The Röntgen ray showed a shadow at the lower end of the tibia about 4 inches from the malleolus. On cutting down on this spot the bone percussion note was dull, and on trephining a well walled-off abscess cavity was found, cultures from which made from the interior of the bone cavity proved to be mixed albus and streptococci in long chains. The cavity was filled with bone wax and the patient made a good recovery. It is difficult to trace the infection in this case or to see why albus, which is a skin organism, should have gotten into a closed bone abscess in conjunction with a streptococcus infection. Moreover, this is the only case in which a closed abscess gave a mixed infection. It is possible for these organisms to have remained in the bone from the time of the first operation, but it does not seem likely in view of the rather delicate nature of both organisms. Aureus has been known to remain viable for years, but so far as the writer knows, not albus or the streptococcus group, which dies rather easily. Three aureus abscesses of unknown origin were opened. One of these was inguinal, no injury, no urethritis; swelling of two weeks' duration drained; culture, aureus. A second abscess, subfascial, not associated with sore throat or tonsillitis, was opened at the angle of the jaw and proved to be also aureus. There was no carious bone or dental caries in connection with this case. The proximity to the mouth suggests a lymphatic course for the infection.

A most interesting case was the following:

The writer saw, in consultation, a man, aged fifty-seven years, with the following history: He had been treated for two weeks by his brother, a physician, for la grippe. He had a chill, fever to 103°; malaria. Later pain in the right wrist, some swelling; then pain in the region of the right hip, edema, swelling. An exploring syringe revealed the presence of an abscess under the fascia lata, which was drained, cultured, and proved to be pure aureus.

It is difficult to trace the origin of this infection. The patient made a good recovery and never showed any evidence of infection elsewhere. The affected wrist suggests a hematogenetic origin, but it was not possible to say that there had been an endocarditis, and in view of the extremely fatal character of endocardial infection of the aureus type, the inference is that no endocarditis had preceded the attack.

A somewhat similar case to this, treated by the writer, occurred in the person of a lady who for three weeks previous to her coming under the care of the writer had recurrent attacks of what was diagnosticated as Pfeiffer's glandular fever. The attack had also been called la grippe. Each of the weekly attacks had been preceded by chill, fever, malaria; the last by some swelling in the neck anterior to the left sternomastoid muscle. This finally proved to be an abscess underneath the deep fascia of the neck and was drained. A streptococcus was cultured from the pus, which was a slow grower, not showing any growth until the fifth day. This lady developed a soft murmur at the aortic orifice, septic wrists and knee, had three convulsions, although the urine was negative, but finally recovered, after the use of a vaccine which was not autogenous but came from the organism of another patient.

Abscesses occurring in post-typhoid are usually found to contain typhoid bacilli in pure culture. This is not always the case as the following case shows: A patient in the fifth week of typhoid, convalescent, developed an abscess at the right wrist, an abscess of the left leg, and abscesses in both arms. Cultures taken from these abscesses proved to be aureus, streptococcus, and diphtheroids. From a tubercular sinus of the neck exactly the same organisms were recovered, although the patients were in different wards and under different house officers and nurses. The streptococcus occurred in pure culture twenty-two times, but was by no means always of equal virulence. In one case, after a pin prick, the cellulitis started in a few hours and involved the lymphatics to the shoulder in forty-eight hours.

One curious case of streptococcic infection was as follows:

A negro came into the writer's service in the Kings County Hospital with a swelling of the axilla and upper arm. His story was that his employer had been operated upon at home for an abscess of the arm and he had cleaned up the room after the operation. The following day he complained of pain and swelling in the right arm and came to the hospital for treatment. The hand was carefully examined for a scratch or abrasion of any kind, but none was discovered, nor was the hand affected at any time, the infection being restricted to the area above the elbow. Drainage showed a pure culture of the streptococcus. Another abscess of the axillary fossa without history of injury or abrasion showed a pure culture of streptococcus in short chains. The most likely source of contagion in abscesses of this type and in, perhaps, all subcutaneous abscess not of traumatic origin is in an infected sweat gland or hair follicle. There was no evidence in any of the cases beyond conjecture, that either of these was the starting point of the infection. Two cases of streptococcic infection occurred in fractures. The first was in the writer's service at St. John's Hospital and was subsequent to the application of a Lane plate for bad oblique over riding fracture of tibia and fibula, with great displacement. The writer has used the Lane plate in 10 cases during the past winter with good results except in this case, which he relates in order that it may at least serve as a warning against the indiscriminate use of the open method in this treatment of fractures. The subject of the fracture was a young man of alcoholic habits who received the injury as a result of an automobile accident. The case was ideal for the open method as the bones, when reduced, would not be held but slid past each other with much over-riding. The operative field was most carefully prepared twice, after the usual method. After the patient was in the operating room, the leg was painted with tincture of iodine, which was allowed to dry. Everyone connected with the operation wore rubber gloves. There was very little handling of the tibia to which the Lane plate was secured, resulting in perfect apposition. The fascial wound was closed with catgut, the skin with silkworm gut, a dressing

applied and a plaster cast. The wound showed evidence of infection on the second day and a window was cut in the cast, the sutures removed and pus found, which was of streptococcus origin. Every effort was made to trace the error in technique if any. The gauze, the suture, and ligature material were tested, and the samples taken shown to be sterile. The nasal cavities of everyone concerned in the operation were cultured and no streptococci found. There was not another streptococcus case in the hospital, and the writer went straight from the operating room of this hospital to another hospital and did three operations, one a gastro-enterostomy, all of which recovered with primary union. Drs. Avery and Garside, of the Hoagland Laboratory, made every effort to hunt down the source of contagion, but failed. The patient ran the gauntlet of prolonged suppuration, multiple incisions, necrosis, and is now, five months after the operation, just beginning to get union. Was the source of this infection hematogenetic? In view of the many cases of closed infection which occurred in this series without the intervention of any injury, we cannot absolutely deny the possibility that an operation wound may become infected from within and not from without.

Another streptococcus infection occurred secondarily in a compound fracture of the tibia, which had beeen wired at the Coney Island Hospital. Three months afterward the attending surgeon did an operation for the removal of some necrosed bone. This was followed by a sharp rise in temperature and evidences of severe infection. The writer saw the case the week after the operation for necrosis, and on examining the patient's heart found a soft blowing murmur. Diagnosis of septic endocarditis, probably of streptococcic origin. Blood cultures showed 100 colonies of streptococci to the cubic centimeter. In spite of treatment by vaccines and antistreptococcic serum this patient died. No cultures were taken from the wound prior to the second operation. The writer desires to make the point that this should have been done and immunizing doses of the organism found and given prior to the second operation. It is evident

that a bacteriological examination of the old wound prior to operation might have served to put the surgeon on his guard and might have avoided a catastrophe. Seven cases of puerperal infection occurred in this series of cases, of which four were of pure streptococcic origin. In these 4 cases blood cultures were taken and streptococci recovered as follows:

Case I.—A. T., January 12. Induced abortion; culture shows long chain streptococci, 200 colonies in 0.5 c.c. of blood; death.

Mrs. E., puerperal sepsis eighth day, blood culture; streptococci in long chains; 12 colonies in 2 c.c. of blood. Culture from cervix, streptococci. An autogenous vaccine was made for this case and she recovered, but developed a deep abscess of the right hip subfascial running in the direction of the thyroid foramen. This was drained, and cultures taken proved to be streptococci. Ten days after drainage she again developed an evening rise in temperature. Careful examination showed no retained pus, no abscess or evidence of inflammatory process in the pelvis. She again received an autogenous vaccine and the temperature fell to normal, after which she recovered. This is the second case of abscess of the upper thigh occurring secondary to a puerperal infection, which has come under the observation of the writer. It is possible that it is of lymphatic origin via the lymphatics which accompany the obturator artery and vein into the pelvis.

Case II.—Induced abortion six weeks previous. Patient seen by family physician one week after the operation for abortion; temperature, 104°; had been told by "operator" that she had la grippe. Sepsis six weeks' duration; no phlegmon. Seen then by writer. Marked endocardial murmur. Pelvis clear. Septic wrists and knees, chills; temperature, 102° to 104°. Blood culture showed numerous streptococci, colonies not counted. The administration of a polyvalent vaccine (Van Cott's formula) and subsequently an autogenous vaccine followed by a remission of all the symptoms. A week later, however, patient embolized her left middle cerebral and also developed septic infarcts in both lungs and died.

The 3 cases of mixed infections were as follows:

Case I.—Peritonitis following abortion. Death. Swabs from peritoneal cavity at autopsy showed streptococci of the large variety, the chains occurring end to end, probably the intestinal streptococci and diphtheroids developing in a very delicate growth on the culture medium.

Case II.—Mixed infection, puerperal sepsis following delivery by students. Staphylococcus, aureus, albus, and streptococcus longus. Recovery.

Case III.—Sepsis following delivery; brought to the hospital. No blood culture; vaginal swab showed colon and albus. Recovery.

Of these 7 cases all were streptococcic in type except one in which only colon and albus were found. This was of mild type. Six of the cases were induced abortions.

The pneumococcus in pure culture was usually found in the empyemas, when there was an intercurrent or preceding pneumonia. There were (4) cases of special interest, of pneumococcus infection in cases other than empyema.

Case I.—A. B., Kings County Hospital. Dry pleurisy, right side, followed by a painful swelling at the region of the right sternoclavicular joint which appeared quite rapidly. Pus from the drainage operation showed a pure culture of the pneumococcus.

Case II.—Pneumococcus infection of the right knee-joint. This was a man in the Kings County Hospital, who came into service after an illness of two weeks. The history given by the patient was that the right knee became swollen and painful after a fall which did not bruise the knee nor break the skin. Patient thought he had rheumatism. Examination showed a much swollen knee-joint full of fluid; temperature, 101° to 104°. Aspiration proved the contained fluid to be pus. Culture showed a pure pneumococcic infection; no pneumonia; no pleurisy. The Mayo operation done for drainage. Pus found to have escaped from the capsule into the intermuscular planes; attempts to save the limb were in vain, and patient died.

Case III.—Compound fracture of the head of the humerus in a stout woman, aged forty-eight years; Kings County Hospital. Wound enlarged; head and shaft joined by Lane plate. Infection, pneumococcus, drainage. This patient did well for a time, but the arm was subsequently removed at the shoulder for a renewal of the infection by the writer's successor in the service.

Case IV.—Pneumococcic conjunctivitis, contracted from patient's daughter, and when first seen was thought to be of gonorrheal origin. Cultures showed a pure pneumococcic infection.

All the cases of suppuration in which the pneumococcus was found were of a severe type. The empyemas were classified as follows: Those following pneumonias, in all but one of which, as was to be expected, pure cultures of the pneumococcus were found. In one case, that of a child who came to the hospital with fluid in the right chest, a bronchopneumonia had been present and the cultures from the drainage operation showed aureus and diphtheroids, the former predominating. An empyema said to have followed an attack of influenza was aspirated, but cultures from the aspirated fluid, though this was turbid, remained sterile. Resection of a rib was done for free drainage. Cultures from the drains gave a Gram negative bacillus which proved to be Friedländer. This patient died. The drained fluid was thin and bloody.

An interesting case of encysted empyema was that of a patient, a man, aged fifty years, with cough and expectoration suggesting tuberculosis. No tubercle bacilli, however, were ever found in his sputum though frequently sought for, but numerous streptococci. The von Pirquet reaction was negative. He developed an encysted pleurisy just posterior to the angle of the scapula, which was drained. Cultures taken from the drainage showed pure streptococci. Although perfectly free drainage had been provided, patient continued to run an evening temperature. Finally he received a vaccine made from his own organism after which his temperature fell to normal.

Five cases of perinephritic abscess came under the writer's

observation and were drained. Four of these were pure aureus, one a colon infection. On the contrary, all of 5 cases of unilateral hematogenous infection of the kidney showed pure cultures of the colon bacillus; the cultures being taken from the small abscesses in the renal cortex after hemisection of the kidney, subsequent to the nephrectomy. No deductions can be drawn from a few cases, but one would naturally expect perinephritic abscesses to be the result of colon infection rather than aureus, owing to the proximity of the colon. In the infected kidneys the origin was clearly hematogenetic, as the abscesses occupied the location of the vascular tufts. This variety of infection is probably never the result of an ascending infection of the bladder, the symptoms being quite different from, and far more severe than, a simple pyelitis or even a pyelonephritis.

This short collection of cases is submitted with much diffidence. Yet few in number as are the cases, the labor involved in the isolation of the infecting organism has been very great and has consumed much time. It is the intention of the writer to continue the work with the assistance and collaboration of the Hoagland Laboratory. In course of time it may be possible to make conclusions of value. It is not impossible that we may find a method of immunizing a patient against infection previous to operation or to sterilize the blood current and tissues after infection has occurred. That is what Ehrlich has done in syphilis. The writer gratefully acknowledges the assistance of Drs. White, Avery, Garside, and Mr. A. W. Lyall, the bacteriologist to the Long Island College Hospital, without whose aid this work would have been impossible.

ACUTE PNEUMOCOCCUS INFECTIONS OF THE EXTREMITIES.

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That the pneumococcus arthrites are fairly common seems apparent from the perusal of an interesting paper by Nitch,[1] who says: "After a fairly extensive search through literature I have found records of 98 cases (100 cases including 2 cases of my own) of arthritis in which the presence of the pneumococcus was definitely proved by bacteriological examination." Mauclaire[2] says: "Pneumococcus pyarthroses are beginning to attract considerable attention. Traumatism preceding chronic arthritis predisposes to the localization of the pneumococcic infection. The pus is thick, creamy, tenacious, greenish yellow. From the symptomatic point of view there is at first a very acute stage, with edema and considerably dilated subcutaneous veins. The pain is moderate; the symptoms tend to improve; the condition may become chronic."

The writer is able to ascertain but 2 instances in which the pneumococcus in pure culture[3] has been recovered from inflammatory affections of the soft parts of the extremities. The first

[1] British Medical Journal, September 21, 1907.

[2] Nouveau Traité de Chirurgie, Le Dentu et Delbet, Paris, 1909, vii.

[3] The literature on this subject is very meagre. W. Hagen (Ueber akute chirurgische Infekt. Krankheiten, Würzburger Abhdlg. a. d. Gesammt. geb. d. Prakt. Med., x, 1910) says that the pneumococcus, or Diplococcus lanceolatus, is closely related to the streptococci, and that it may cause a series of pathological processes, of the most variegated character, in addition to pneumonia. Secondary inflammations in any tissue or tissues may develop as a sequel of pneumonia through metastasis, but these inflammations may also occur primarily, as the pneumococci are able to enter the organism in other ways than by way of the lungs. They have been found in the accessory sinuses of the nose, the tympanic cavity of the ear, etc. Their cultural behavior resembles that of streptococci, from which they are sometimes distinguished with difficulty.

of these is reported by Sabatier.[1] It concerns the case of a young soldier who was kicked by a horse in the middle third of the antero-external region of the left leg. No bone was broken. The condition seemed to be that of a simple contusion. Four and one-half months later a phlegmonous inflammation of the leg developed. An abscess was incised, and a thick, dark greenish pus evacuated. The centre of the purulent focus seemed to lie in the subcutaneous cellular tissue between the skin and the muscular aponeurosis. Examination of the pus showed the presence, in large quantities, of the Pneumococcus lanceolatus. Slow healing.

The second observation was made by T. Arnold Johnston.[2] He pricked the third finger of his left hand while resecting a child's rib for pneumococcal empyema. There was an inflammation of the cellular tissue of the finger and hand, the condition being ushered in by a chill and vomiting. There was a continuous high fever for several days, crisis on the fifth day, with profuse perspiration, and immediate cessation of all grave symptoms. Various incisions were made but no pus was found. The serum from the wounds contained pneumococci in pure culture. Johnston says: "The course of the disease bore a remarkable resemblance to the typical course of croupous pneumonia, and is perhaps suggestive of a different line of treatment for similar general infections, abandoning surgical procedures. The incisions certainly relieved tension by bleeding freely, but no pus formed, and the resulting cicatrization has produced considerable stiffness and tenderness which is yielding slowly to massage. In a similar case I should be inclined to examine the serum for pneumococci, and if this were found, treat the case as an ordinary pneumonia,[3] giving morphine in small doses for the pain."

In close connection with this case of Johnston's the writer would cite the following personal observation:

[1] Contribution a l'étude des localizations extrapulmonaries primitives du pneumocoque, Archiv. Gén. de Médecine, 1906, No. 39.

[2] A case of pneumococcal infection, British Medical Journal, October 12, 1907.

[3] The writer is unable to agree with this suggestion.

CASE.—Mr. X., a machinist, aged twenty-six years, injured the last phalanx of his left thumb on March 29, 1911, sustaining a contused and lacerated wound of moderate extent. He was immediately accorded suitable aseptic care. Infection slowly developed, spreading up the forearm and arm in the form of a superficial lymphangitis. Through the courtesy of Dr. L. T. Durbin he was seen by the writer on April 6. At this time the thumb was suppurating moderately, the hand was somewhat swollen, there was a superficial lymphangitis on the anterior aspect of the forearm and arm. There was a tender mass the size of a small apple in the axilla. The pulse was 80 to the minute, the temperature 100.6°. The patient did not complain of feeling definitely ill. The moist boric compresses which had been instituted by the attending physician were continued. Eighteen hours later the patient had a severe chill, the pulse went to 108 to the minute, the temperature to 102°. When the limb was examined it was found that the inflammatory process had extended to the deeper tissues, the whole extremity being much swollen and reddened, painful, and tender. The patient felt correspondingly ill and depressed, the entire picture was that of a rapidly extending septic infection.

Operation under ether, April 7. Multiple free incisions through the deep fascia from the thumb and hand to the shoulder. No pus found. The tissues were boggy and edematous. Cultures taken from the deep tissues of the arm just below the shoulder were submitted to Dr. E. C. Hill for examination. Dr. Hill, after very careful examination, reported that he found pure cultures of pneumococcus.

After the incisions were made the process rapidly subsided. The following day the temperature was 99.4°, the pulse 90. The axillary enlargement rapidly disappeared. The wounds made in the forearm and arm healed without suppuration, the thumb suppurating moderately. Cultures taken April 12 showed pneumococcus and staphylococcus, the latter doubtless due to accidental infection. The case went on to a relatively early recovery.

While this process resembled a streptococcic one, it seemed to the writer less virulent than one observes in the ordinary diffuse streptococcic infections, and it subsided rather more rapidly than does a streptococcic process of similar extent.

A second observation concerned a young gentleman serving at the time as a surgical interne at St. Joseph's Hospital in Denver. In February, 1911, he developed a small furuncle at the back of the left hand, apparently originating in a hair follicle. The hand became moderately swollen and was tender. Incision revealed a little pus and from this the pneumococcus in pure culture was recovered. Three or four other small furuncles followed, each showing the pneumococcus. Clinically the process did not seem to differ materially from that seen in an ordinary Staphylococcus furunculosis.

DISCUSSION.

Dr. John B. Roberts, Philadelphia.

At the present time I have an infant, previously operated on for harelip and cleft palate, quarantined unnecessarily, it seems to me, in a hospital ward by the Health Department, because she has what they call the diphtheria bacillus in her throat. She has no symptoms of disease, either in temperature, pulse, or respiration. The Board of Health cannot be induced to see that this is probably not the true diphtheria bacillus, and so allow the child to go home. Boards of Health in all cities should know what Dr. Bristow has so plainly set before us, and such conditions as he mentions should be kept clearly in mind by all examiners.

In Philadelphia, recently, a man applied to the court to see whether he, the father, could be legally kept in the house for three months and away from his work, because one of his children had what was said to be the diphtheria bacillus in its throat, although it had long been free from symptoms of disease. An injunction was asked, I understand, to restrain the Board of Health from continuing the quarantine. Two experts were appointed, I think, to determine the nature of the organism found present in the culture taken from the child's fauces and pharynx, and they expected to inoculate guinea-pigs to determine the question of the organism's nature and pathogenic power.

Dr. C. B. G. de Nancrède, Ann Arbor, Mich.

It seems to be a matter of surprise that we should have any other source of pneumococci infection than one of the consequences of pneumonia, viz., empyema. I think that a large number of those present, if they had their throats carefully examined now, would find numerous pneumococci present.

Dr. Maurice H. Richardson, Boston.

There has been in Boston, within the last three or four weeks, a constitutional infection of the most mysterious kind. It was supposed to come from the milk of a first-class dairy. In one day I saw a phlegmon of the neck; a phlegmon, as it turned out, of the fascia lata and all the muscles; a sepsis around the left hip and total gangrene of the lower extremity—all preceded by a simple tonsillitis. Another practitioner had two fatal cases of peritonitis. In another instance there was a fatal peritonitis with a questionable appendicitis; and there were several other cases showing general infection.

There were many rumors about town as to the cause of this infection. Everyone was run down by the farm authorities, who were more anxious than anybody else to find out whether there really was any cause in the milk. This farm takes the most rigid precautions to make its milk supply of the very best. Probably it is at the head of the dairies of New England in the extreme care it takes that everything shall be bacteriologically perfect. Such rumors as prevailed were run down and were found to be groundless. In one community there were more cases of infection where none of the milk of the dairy in question was used. No real cause for the infection has been found. Dr. Bristow's paper, in connection with this mysterious epidemic, is of very great interest to me.

The patients with peritonitis who were operated upon died; the patients whom I saw in Boston and were not operated on lived. I saw one case in which I thought that there was an appendicitis, but there did not seem to be the pain which usually accompanies that condition, and I hesitated to operate. The patient, however, developed, from a trivial attack of indigestion, with a normal temperature and pulse, a fulminating peritonitis. The temperature went to 105° and the pulse to 180. The boy died. This patient was in New Hampshire, far from the dairy suspected in the other cases; and the case goes to show that the milk source of infection was more a theory and a coincidence than a probability or a possibility. It will be interesting to know whether any real source of infection will follow the sincere efforts of the owners of the dairy to demonstrate the truth.

Dr. Bristow. With reference to Dr. de Nancrède's remarks, I would say that in the throat we have all sorts of organisms, 65 per cent. of all individuals harboring the pneumococcus. The point of interest to me was its presence in distant tissues of the body in cases having no pneumonia before. It is by no means simple to trace the pneumococcus infections I mention in my paper from the mouth to the points infected.

SUPPURATION IN ONE-HALF OF A HORSESHOE KIDNEY.

By JAMES E. THOMPSON, M.D.,
GALVESTON, TEXAS.

Horseshoe kidney is not of very frequent occurrence. Roth found it five times in 1630 autopsies at Basel (*i. e.*, in 0.3 per cent.); in 832 male cadavers, twice (0.24 per cent.); in 798 females, three times (0.37 per cent.). Although statistics vary, these figures may be taken as fairly representative, and we may expect horseshoe kidney in one cadaver out of three hundred. It will be seen that this is not quite a negligible quantity, and the frequency of the condition demands that at least a thought should be given to the possibility of its presence when dealing with any renal or obscure abdominopelvic tumor.

The case that forms the basis of this paper was one of pyonephrosis occurring in a young girl, aged fifteen years, who presented symptoms pointing very strongly to a diagnosis of renal calculus.

Case I.—*History*. A. M., aged fifteen years, a well-nourished girl, came under my care in July, 1908. For six years she had suffered from pain in the left side. The situation of the pain was in the lower part of the lumbar region and the left iliac fossa. It was more or less constant, and was associated with irritability of the bladder shown by frequent painful urination. At irregular intervals it was paroxysmal and very intense, at which periods it was accompanied by severe chills and high fever. No change had been noticed in the quantity of the urine, nor had the quality been altered up to two months before examination, when it became turbid and of an offensive odor. At no time had any blood been noticed in the urine, nor had gravel

or anything resembling stones been passed. During the last two months the paroxysms of pain had been so frequent that the parents were very anxious for some medical treatment.

Examinations. The urine was slightly alkaline; specific gravity, 1022; contained quantities of pus. It was free from tubercle bacilli, but contained myriads of colon bacilli. There were no crystals. Physical examination revealed very little. No swelling could be felt in either loin or groin, but pressure in the left iliac fossa elicited some pain.

Operation. As the child had never menstruated and was extremely nervous, no vaginal examination was made, but an anesthetic was given, and arrangements made to do a radical operation if it was found necessary. Under the anesthetic a slight swelling was found in the upper part of the left iliac fossa, and it was decided to make a low lumbar incision and explore it retroperitoneally. An incision was made like that formerly employed for the retroperitoneal exposure of the common iliac artery. A flattened cystic tumor was found lying in the iliac fossa and extending as far as the brim of the pelvis. Absence of the left kidney was demonstrated in its normal lumbar position, so it was decided that the tumor was probably a misplaced kidney. While it was being exposed and isolated, an opening was accidentally made into one of the cystic swellings, out of which pus flowed. The interior of the cysts was now explored, but no stones were found. That it was without doubt the kidney was easily shown by the bloodvessels, which entered the mesial and upper border, while the ureter came out of the same border and coursed over the front of the swelling on its way to the bladder. While the lower end of the kidney was being isolated, it was seen to narrow materially into a kind of neck and then to expand immediately into a mass that lay transversely over the front of the last lumbar vertebra. Thinking of horseshoe kidney, I examined this mass carefully and satisfied myself that it was the right kidney. A clamp was applied to the narrow neck, the intervening glandular tissue was crushed, and a ligature applied in the groove, after which the left diseased kidney

was removed. The ureter was very short (about one and one-half inches long), and it was ligatured close to the bladder, the cut end being disinfected with phenol.

Convalescence was uninterrupted, the right kidney being able to carry on the excretory functions without difficulty.

Pathological Specimen. The removed organ was a typically dilated pyonephrotic kidney, exactly the counterpart of many kidneys the seat of renal calculi. The cavities contained thin, purulent urine, and were only moderately distended. No signs of calculi were discovered, nor was there any evidence of tuberculosis. The organ was flattened at the time of observation, and it was evident that drainage along the ureter had been very free.

It is possible that the kidney at one time had been the seat of one or more calculi, which at some time previous to the operation had become disintegrated and passed out without the patient's knowledge. But, on the other hand, it is just as probable that the case was one of primary hydronephrosis which had become infected secondarily with pyogenic organisms (colon bacilli), weight being given to this latter suggestion by the frequency with which horseshoe kidneys show evidences of hydronephrosis, in greater or less degree.

The tendency of horseshoe kidneys to become diseased is very marked, and I have been able to find records of 6 cases of hydronephrosis (Socin,[1] Barth,[2] Israel,[3] and Geiss[4]); of 5 cases of calculus (Phillips,[5] Braun,[6] Rumpel,[7] Israel and Schuchardt[8]); 1 case of sarcoma (König[9]), and 1 case of pyonephrosis (Sutherland and Eddington[10]) unassociated with calculus. Of these, only 3 can be characterized as cases of pyonephrosis (Phillips', Braun's, and Sutherland and Eddington's). One (Sutherland and Eddington's) was a case of pure pyonephrosis unassociated with either tubercle or stone, in which respect it resembles the case that forms the subject of this paper. The other 2 were cases of calculous pyonephrosis (Phillips' and Braun's), and one of them is remarkable, owing to the fact that both sides of the kidney were infected and contained stones. Only one of the patients (Braun's) was operated on, and this case proved fatal

from hemorrhage, caused by tearing the left renal vein. The history of these 3 cases I have appended below.

CASE II.—Reported by Sutherland and Eddington.[10] The specimen was removed post mortem, from a male child, aged three years. Pus had been observed in the urine for two months before operation. An abscess in the lumbar region was opened, and continued discharging until death.

Pathological Specimen. The conjoined kidney was shown in section, and the two halves were seen to be joined by a broad isthmus of renal tissue. The left side of the specimen was seen to be greatly enlarged. The pelvis was dilated, and there were cavities representing dilated calices which largely replaced the renal tissue and still contained remains of pus. The left half of the isthmus showed a similar lesion. The right side of the specimen and corresponding portion of the isthmus were normal. In addition, there was an abscess cavity outside the left kidney communicating with the internal cavities. Microscopically examined, the lesion in the kidney presented the characters of an ordinary pyonephrosis. There was no evidence of tubercle. The right half of this fused kidney presented microscopically a normal structure.

CASE III.—Horseshoe kidney, one-half normal, and the other half showing pyelonephritic changes; reported by H. Braun,[6] professor of surgery at Heidelberg.

History. A woman, aged forty-five years, was admitted to Czerny's clinic, February, 1881. Previous history good. Present trouble began in 1879, with severe pains in right iliac region, accompanied by cloudy urine, with heavy sediment but no admixture of blood. Six months before examination anorexia appeared, which resulted in considerable emaciation.

Examination. There was uniform distention of the lower portion of the abdomen. A tumor the size of the head was palpable; of firm consistence; no fluctuation could be discerned. Exploratory puncture resulted negatively. The urine drawn with catheter, contained a large amount of albumin and pus; no other abnormal findings. There was enlargement of abdominal

lymphatics in the region of the tumor. Probable diagnosis: Pus in pelvis of kidney.

Operation. March 7, 1881. In the attempt to loosen the tumor it was found that it was firmly united posteriorly with the aorta and vena cava; venous hemorrhage occurred, which could with difficulty be controlled by ligatures. Operation had to remain unfinished; patient did not regain consciousness, but died while abdominal wound was being closed.

Autopsy. This showed horseshoe kidney, one part of which (the left) was normal, the other (the right) showing pyelonephritic changes. The pelvis of the kidney and calices were considerably dilated and contained six voluminous arborizing calculi with a longitudinal diameter of 7 cm. and a thickness of 2.5 cm. The right ureter, which passed, like the left, over the anterior surface of the tumor, was dilated and firmly enclosed in a capsule of firm consistency. The left renal vein derived several branches from the pelvis of the kidney. The right renal vein and the two renal arteries were normal. The hemorrhage during the operation was occasioned by injury to the right renal vein, just immediately before its opening into the inferior vena cava. Posteriorly, the tumor was firmly attached to the aorta and the vena cava.

Case IV.—Renal calculus in connection with a horseshoe kidney, reported by N. R. Phillips.[5]

History. W. M., aged forty-one years, admitted to hospital under care of Dr. Whitehead Reid, May 31, 1902. At the age of three years he had passed with his urine a stone about the size of a barley corn. At the age of twenty he passed a "mulberry" calculus the size of a haricot bean. He only once passed blood with the urine; this was at the age of twenty-one. At twenty-eight he became ill with cystitis and had never been quite well since. The urine became thick and sticky; there was pain in the loins and both groins, especially the right, which was worse after exercise. He had lost flesh during the last twelve months and had become very weak. He had been sent to hospital with a diagnosis of intestinal obstruction. He was very sallow

and in an extremely debilitated condition; the pulse was rapid and of very low tension. There was some indefinite resistance to be made out in the right hypogastric region, but no bulging in the loins. There was a history of nine days' constipation, and vomiting had become almost incessant. The urine was neutral in reaction, viscid, and half pus. The bowels were moved after repeated enemas. The bladder was sounded, but no stone could be detected. An operation on the kidneys was considered inadvisable on account of the great state of exhaustion.

Autopsy. Kidney was found to be horseshoe-shaped, the two lateral portions being united below. On the right side the kidney was greatly distended, and formed a large cystic swelling. Both sides were firmly bound down by adhesions to the posterior abdominal wall. The right ureter was embedded in a large mass of fat. On section of the right half of the kidney a large quantity of pus escaped, and nothing remained of the kidney substance but a thin-walled sac. Two faceted calculi were lodged in the commencement of the ureter. The left half, on section, was also found to contain pus; the pelvis was greatly dilated and occupied by a very large branching calculus, which extended into the kidney substance, so that the latter merely formed a thin coating for the stone. The weight of the kidney, including three calculi after removal of the pus, was 22.5 ounces.

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DISCUSSION.

Dr. William J. Mayo, Rochester, Minn.

This paper is an extremely interesting one, and brings up the point that many of the congenital anomalies of the kidney, about which we have been told by anatomists and which we formerly could not find because of diagnostic deficiencies, not only exist, but frequently cause trouble. One is impressed with the fact that through modern surgical methods the operative side of surgery outstepped, for a time, the diagnostic side. But within the last few years, by means of cystoscopic and ureteral examinations in conjunction with the radiograph this has been changed. For example, in regard to anomalous renal bloodvessels as the cause of intermittent hydronephrosis, the anatomist described them, but the surgeon did not for a long time recognize the pathological relationship. In a number of cases of intermittent hydronephrosis observed by us, in not less than one-half were the symptoms caused by anomalous bloodvessels, and I am convinced that the surgeons who have not found this condition have not in the past made as careful examination as they will in the future; the fact, I believe, cannot be successfully disputed. Renal anomalies are not infrequent. For instance, we have met within the last year with three cases of horseshoe kidney in which one-half was giving rise to trouble, but in only one case was the trouble sufficient to necessitate operation. The diagnosis, in other words, does not necessarily mean that the case must be operated, but is an adequate explanation to the patient, and enables them not only to know the cause of their symptoms, but in the future if it becomes necessary to operate, the operation can be guided by the work of the cystoscope, ureteral catheter, and *x*-rays.

I have in mind an interesting case of a woman, aged fifty-four years, who had lost her appendix and had an operation on her gall-bladder; an attempt had also been made to operate for a movable kidney which she did not have. These symptoms since sixteen years of age. It was very beautifully shown that she had an intermittent hydronephrosis in one-half of a right horseshoe kidney, yet the symptoms were not sufficient to justify an operation.

Another case very similar to that reported by the author came under our care. A girl, aged sixteen years, was suffering from quite similar symptoms. A low horseshoe kidney, in which the lower half gave rise to trouble, the short ureter of this side was, as usual, attached to the bladder in the higher situation. In this case the patient had severe symptoms, had undergone various operations, yet she had a

comparatively small amount of urinary symptoms, although there was a certain amount of pus in the urine. Operation showed the condition of the ureter perfectly; it was kinked and obstructed just at the pelvic juncture. In this horseshoe kidney the anterior half contained 30 c.c. of infected urine. The ureter leading to the second sound half of the kidney was buried posteriorly. It was difficult to find the division between the two halves of the kidney. The only guide we could get was by the compression of the renal bloodvessels and then watching the change of color to see where to divide the kidney in order to secure the half connected with the infected hydronephrosis.

Dr. George E. Brewer, New York City.

I agree that this paper has brought up an extremely interesting subject. These cases are very obscure and at times very difficult from a diagnostic point of view. The case reported is so similar to one I have recently had that I will say just a word about my case.

The patient had been admitted to the Roosevelt Hospital with a diagnosis of perirenal abscess. The abscess had been opened in the flank and drained, and the patient had gotten up and gone about with a continuous fistula in the lumbar region. No attempt was made to find the original source of infection, but it was supposed to be from the kidney. The man came into my service in a state of more or less chronic sepsis, with a discharging fistula and evidences of an infected kidney. The ureteral catheter was attempted, also the cystoscope, but the presence of a very grave cystitis and a contracted bladder prevented any satisfactory employment of these measures. We made an attempt to expose this kidney, and found a chronically infected organ. There was evidence of a collection of pus in the pelvis as well as a certain amount of destruction of renal tissue. The presence of the perirenal abscess had resulted in a mass of adhesions so dense that it was almost impossible to separate the kidney from its fatty capsule. The dissection was carried on with difficulty downward, and in attempting to reach the lower pole we followed it downward into the pelvis and found it passed transversely across the aorta. In other words we had to do with a horseshoe kidney of which the upper and left half was diseased. The next question was where to divide. The upper part of the kidney was distinctly destroyed, the lower part infected, but as we passed down toward the transverse portion it looked healthy. Not having had the advantage of a cystoscopic examination, I was at a loss to know whether both ureters were given off on the left side or whether we had a single ureter on the other side. It took a good deal of time to dissect away

the perirenal exudate to see if we had a second ureter. Fortunately the man made a very prompt recovery.

Such cases I think are particularly difficult if one has not had an opportunity of verifying the two ureters, and if, moreover, the kidney is embedded in a mass of inflammatory adhesions extending over a number of months.

Dr. Kenneth A. J. MacKenzie, Portland, Ore.

I wish to show you a kidney which is typical, so far as form is concerned, of horseshoe kidney. I never saw one resemble this form more closely, still this kidney is the companion of the one remaining. This patient came to me complaining of abdominal and pelvic pain, and he presented occasionally the symptoms known as Dietl's crises. I never suspected kidney disorder and did not think the kidney diseased. It came to operation, and I regarded it as a movable tumor connected with the omentum or mesentery, and removed it. It was this kidney which caused the pressure symptoms complained of. It was an ectopic horseshoe kidney with two sets of vessels. I only removed it after satisfying myself that the other kidney was in place. I brought this specimen to the meeting thinking it might be interesting, because I had never seen such a strange type of kidney before.

The same season a young woman came into my service who had complained of pelvic disorders. She was a Swede, and with the aid of an interpreter I found she had some serious pelvic trouble. I attempted a vaginal examination, but found it impossible, there being no vagina, but by rectal touch I found what I believed to be a tumor, very dense and unyielding. I made an abdominal exploration and verified the following conditions: There was no uterus in the usual situation, and no vagina, and the tumor could be felt below the sacro-iliac synchondrosis behind the peritoneum. Above, in the abdomen I found an ovary floating and pulled it down, and it led to a Fallopian tube, a broad ligament, and a segment of the uterus. There was a corresponding condition on the opposite side, and these elements could be brought together, showing the normal outlines of the uterus and adnexa. There was nothing pathological in the peritoneum, which I opened in front of the tumor, which proved to be a tremendous ectopic horseshoe kidney. Huge vessels were connected with it, and, of course, nothing could be done; there were adhesions, and I could not see where the vessels sprang from.

Dr. M. L. Harris, Chicago.

I wish to emphasize the necessity of conservatism in operating on horseshoe kidneys. Some six years ago I saw in consultation a young

woman, aged thirty years, who had been suffering for some time with attacks of pain in the right side in the region of the kidney. On examination a distinct mass could be felt in the right side which was thought to be a low movable kidney. The urine was normal in that it contained no pathogenic elements. The cystoscope showed the right ureter in its normal position and we were able to catheterize the right side without difficulty. The left ureter could not be seen. A distinct fold, however, was present in the bladder and the urine could be seen coming from behind this fold. I used the segregator, and was able to get urine from both sides. The mass on the right side was larger than a normal kidney. I therefore thought I had an intermittent hydronephrosis in a right kidney which had been movable and which had become fixed in a low position. I opened up through the lumbar region and soon found that I had to do with a horseshoe kidney with a dilatation of the pelvis on the right side. There were two ureters coming from the pelvis and the pelvis was on the concave side of the kidney and therefore directed upward. These two ureters were soon, however, converted into a single ureter, which passed into the bladder. The ureters were distinctly compressed, as they passed over the anterior surface of the kidney, and to this I attributed the fact of the dilatation of the pelvis. There were two or three arteries entering the kidney and several veins, as is not unusual. What to do to remedy the condition was a problem. I attempted to solve it by freeing the ureters as they came from the kidney, and in order to do away with the sharp kinking or compression of the ureter I took the perirenal fat and tucked it under the ureters so as to give them a large curve. In doing this I succeeded in tearing one of the renal veins. This I closed by suture. After tucking the fat under the ureters and giving them a large curve from the pelvis I closed up the wound. The patient made a very good recovery and the attacks of pain ceased.

About a year later the patient returned with a distinct enlargement in the left side of the abdomen. She was now running a temperature, there was pus in the urine, and tubercle bacilli were easily found. Knowing she had a horseshoe kidney, the question of what to do was again a serious problem. I cut down on the left side, found a distinct pyonephrosis of tuberculous origin, and removed the left half of the horseshoe kidney. This patient made a good recovery from this operation, and I saw her recently, six years after the operation, and she is now perfectly well and in good health.

This case shows the necessity of conservatism, because if anything radical had been done with the right side of the horseshoe kidney the patient would have been lost when the other side became infected with tuberculosis.

SURGICAL TREATMENT OF FISTULA IN ANO WITHOUT MUTILATION OF THE SPHINCTER.

By KENNETH A. J. MacKENZIE, M.D.,
PORTLAND, OREGON.

The object of this study is not to advocate a new method because it would appear that in the search of new methods in this, as in all branches of surgery, it is found that "there is nothing new under the sun."

The writer of late has found a few cases of anal fistulæ in which a departure from present standards has seemed to be productive of results, apparently shortening the term of treatment and obviating the disagreeable consequences of the radical operations at present in vogue. The fact that the method has been used mainly in inveterate cases, which in some instances had resisted all manner of topical and operative treatment over long periods of time, furnishes the hope that the method proposed will fit into a large enough number of cases to justify its *raison d'être*.

It is not intended to include in the scope of this study all varieties of fistulæ that are found affecting the rectum and its neighborhood. Obviously enough it is proper to exclude those forms which are strictly extrinsic and which originate, for example, in diseases of the pelvic bones, diseases of the bladder, prostate, urethra, and other contiguous organs and parts which extend very readily to the perirectal tissues and ultimately invade the bowel, simulating very closely the types under consideration.

For the same reason fistulæ that have a specific constitutional origin are excluded, except the tuberculous forms which afford special indication for the method of treatment herein advocated.

Almost uniformly the accepted treatment of complete fistula in ano consists of the complete division of the structures involved between the two ends of the fistulous track, and in the incomplete forms the rule has been to create a terminal orifice by force either within or without and lay bare the track, forcing the surface to heal by granulation.

In the case of simple, submucous anal fistula the method is without fault. In the varieties of rectal fistula having their internal terminus without the bounds of the internal sphincter or between the sphincters, the method is also applicable, notwithstanding the fact that even in these cases a partial loss of sphincter control occasionally results.

In that group of cases in which the fistulous track has its internal orifice beginning at some point within and above the internal sphincter or in some part of the rectal wall the complete section of the structures involved always results in some degree of impairment of sphincter control causing very often a state in which there is much inconvenience and discomfort, if not abject misery.

Methods of operation have been devised to obviate these results, but almost without exception the treatment of fistula in ano stands as it stood one hundred years ago.

The first and practically the only radical departure from old methods was the complete resection of the fistulous tract beyond its bounds and its subsequent suture. This method has been successful in selected cases generally speaking when the infective process had ceased in a single, direct, fistulous track, rendered sterile through lapse of time. It has failed so often and so frequently made a bad state worse that it is safe to say that the tendency of surgeons is to abandon it. It is absolutely contraindicated in infective states and in complex rectal fistulæ.

A study of the distribution and direction of rectal fistulæ based upon anatomical lines of cleavage is all important in this study. Rectal fistulæ undoubtedly originate within and without the bowel. A streptococcus or mixed infection of the integuments covering the buttocks will sometimes penetrate the

planes of fascia, and following the trail of the lymphatics and vessels and lines of least resistance lead to the rectal wall and penetrate. That complete and incomplete forms of fistulæ with all manner of ramifications may originate in this way is without doubt.

The greatest number of fistulæ of the type with which this study deals originate within the bowel, and the internal orifice of the track will be found in most cases at the anorectal junction, generally speaking within the posterior quadrant of the anal ring.

The sequence of events is (1) diminished resistance, (2) trauma, (3) invasion of microörganisms, (4) ulceration, (5) perforation, (6) infiltration of the fat layers, (7) formation of abscess. The spread of the abscess afterward and its final localization determine the fistulous tracks and zone.

It is believed that fully three-fourths of all rectal fistulæ originate within the lumen of the bowel. The tendency of fistulæ that result from ischiorectal abscesses originating without, is to perforate the rectal wall above the level of the external sphincter; whereas, rectal fistulæ which result from abscesses originating within the bowel tend to perforate through the sphincters or between them.

The submucous and the combined submucous and subcutaneous varieties afford exceptions to this rule, rising as they do at times to high levels in the rectal walls.

Stercoral or pressure ulcers are sometimes found in the sigmoid and rectum, which perforate and cause perirectal abscesses.

In the service of a colleague at the present time is a case of fistula, the outer opening of which is in the right groin, the internal opening beyond the reach of the sigmoidoscope, situated probably in some part of the colon. Water forced into the rectum makes its escape freely through the fistulous track. The history of this case makes it evident that the ulcer was the result of chronic constipation.

When an ulcer perforates the rectal wall and an abscess emerges, its course and spread are determined by various factors.

If the abscess is small, the resistance strong, and the inflammatory action moderate it may take a straight course to the surface and point, leading to the formation of a single, straight, direct track which after a variable period of activity will contract and form a canal with a dense, limiting, fibrous wall.

This is the simplest type of fistula and is amenable to easy surgical cure, yielding readily even to proper topical treatment. Such fistulæ as these because of their accessibility will often yield to the use of Beck's paste, which obviously enough would not avail in the treatment of the complex forms herein referred to.

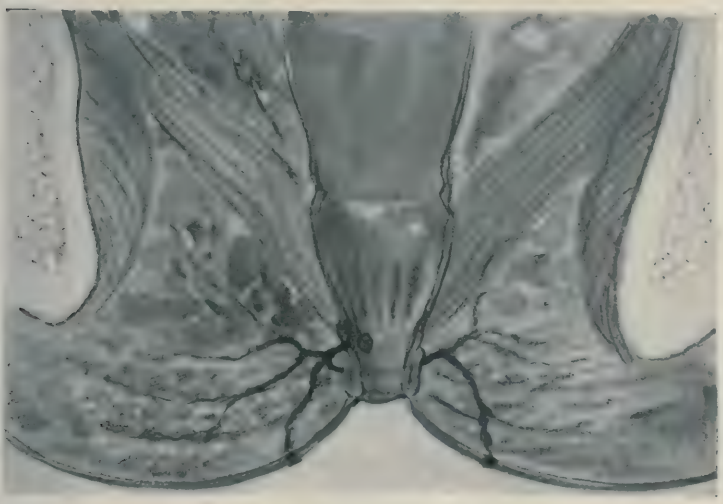

FIG. 1.—Sectional view of pelvis showing tendency of complex anorectal fistula to branch into any one or all of the concentric layers of fat in the buttocks and rectal fossæ, and to terminate in blind ends (diagrammatic).

The superimposed and concentric arrangement of the fat layers in the buttocks and perirectal region has a very important influence in determining not only the boundaries of any forming abscess, but the direction and distribution of the succeeding fistulous tracks; thus, an abscess which has left the rectal wall may course into the deepest layers of the fat next to the gluteal muscles, and in this plane of fat and connective tissue, divide

and subdivide into branches, which, turning hither and thither, become lost in blind ends in the fat, giving no evidence of their existence by any palpable or visible signs without; draining, however, toward the skin and finding an outlet at or near the anal margin. In like manner the abscess may emerge from the point of perforation in the rectal wall in any one of the well-marked layers of connective tissue or occupy each layer definitely.

In other instances the spread and distribution of the fistula is general with all the fat layers and fossæ involved, the whole region then becoming literally honeycombed with fistulous tracks, all draining toward a common point without.

This tendency of rectal fistulæ to follow definitely the planes of tissue is even seen in the most superficial varieties which are typified in those not uncommon forms in which the abscess and its succeeding fistulæ are strictly submucous, subcutaneous, or both combined.

In peri-, retro-, and ischiorectal abscesses the lines of cleavage are followed in the same general way. In the first two varieties the abscess may take a course upward and perforate the rectal wall above the sphincter level or even above the levator ani muscle, or course downward and point in the usual situation. In the former event the discovery of the fistula may be difficult; in the latter it may be mistaken for and incorrectly treated on the same lines as the so-called blind external fistula.

The most complex form of rectal fistula is that which on one or both sides of the rectum has branches like the tentacles of an octopus, passing into the various fat fossæ surrounding the bowel and burrowing deep into the fat layers covering the buttocks, having, perhaps, only one outlet. This type of fistula which on the surface may have all the earmarks of a simple fistula may be approached by a radical process of treatment with a very reasonable prospect of complete cure, but not by the methods commonly in vogue.

The examination of a large segment of the buttock which was resected for the cure of one of the cases referred to in this study illustrates in a striking manner the tendency of anorectal fistulæ

after perforating the rectal wall to occupy one or other or all of the fat layers by branching in various directions, at times pointing to the surface, but more frequently terminating in blind ends within the layers occupied, all converging like the branches of a river into one channel.

In the same specimen was seen, following the same distribution, many branching lines of cicatricial tissue, showing that some of the sinuses had healed, while others seemed to be in the course of a slow process of extinction.

Surgeons who have observed this complex type of fistula will agree that the operative measures in common use not infrequently fail even when the most radical steps are taken. The reason is plain. If a complete section is made of the fistulous track into the rectum, including the division of one or both the sphincters, and all care is taken to lay bare all visible and accessible tracks, if one of the many branching tracks remain, and it is impossible in many cases to note them all, it may be laid down as a law and for the most obvious reasons that the fistula will persist *in situ*. So often is this result observed that the fistula under the conditions named could very well be termed the "paradoxical" fistula.

Several cases have been observed in which apparently very complete operations were performed by different operators and in all the last condition, if anything, was worse than the first, the fistula persisting in loco with some degree of incontinence a feature of all.

Why does the fistula persist? Plainly the answer is that whereas the main fistula was properly attacked and a complete section made of the intervening tissue into the bowel, some remote branch or feeder some distance removed from the field of operation concealed in one or other of the fat layers, remained to determine a relapse of the morbid process. The ultimate result of incontinence in these cases which was not the result of the first, but rather the continuous effect of the later operations is explained on the ground that the first incision divided the external sphincter completely, and the internal

sphincter in part only, leaving enough power in both to control the bowel adequately; the succeeding operations performed in exactly the same region and on the same theory of treatment, dividing more and more of the internal sphincter, of necessity the time comes at last when the remnant of the sphincter is divided, incontinence thereupon resulting.

FIG. 2.—Proximate and distant branching and symmetrical spread of horse-shoe fistula, having two orifices without and one within the bowel. Scheme of flap formation for adapted cases.

It will sometimes happen that the abscess on emerging from the rectal wall will invade both sides simultaneously, or if one side alone is invaded the process may readily extend to the opposite side, causing ultimately a symmetrical distribution of fistulæ of the character described in both buttocks.

To this group belong the several varieties of so-called horse-shoe fistulæ which more than all other forms of complex fistulæ require radical treatment.

According to Tuttle, in general hospital practice in this era of advanced surgery, operative failures in a large number of cases investigated amounted to 45 per cent.

Proctologists inveigh against these figures and protest that the operations are performed by incompetents, which term includes surgeons, and that in their hands the figures indicating failure would be negligible or nil. Is this true?

Certain facts must be connoted. (1) The divulsion of the sphincter alone is known to cause incontinence, even when done with care and without apparent damage to the fibers of the muscle other than their undue stretching. (2) The single simple section of the two sphincters at a correct angle will sometimes cause incontinence, and there are added dangers when the section of the sphincter is associated with its previous complete divulsion. (3) The single simple section of the external sphincter alone at a correct angle is also known to cause well-marked incontinence. (4) It is held by competent authorities that incontinence may be caused by division of one or other of the nerves supplying the parts in question. Unfortunately, for the force of this particular argument, anatomists have not yet made clear the exact manner of the end distribution of the nerve supply of this peculiar group of muscles. If one could imagine a single nerve trunk reaching a circular muscle like the external sphincter and furnishing half of its circumference with the power of motion and control, one could readily understand that its division could easily be effected by a fortuitous cut properly directed with reference to mere technique and cause a hopeless paralysis of the part. However strong the asseverations of writers and others that operative failures and incontinence following surgical procedure are a reproach to surgery and a stigma on the particular operator who meets them, the fact remains that there are abundant reasons for their occurrence apart from any system of treatment, and that every surgeon and proctologist, if he tell

the truth, will admit a very considerable percentage of operative failures, and an occasional case of incontinence as long, at least, as present surgical methods are in vogue.

It is thought that one of the factors that has retarded the progress of surgery in the treatment of anorectal fistulæ is

FIG. 3.—Trap-door flap lifted and fistula with all its branches reflected in the flap. Scheme of extirpation and approach to the outside of the rectal opening of the fistula.

the paramount position that has been given to the principle of drainage in the treatment of this disorder.

A minute study of a fistulous channel with all its ramifications reveals readily that its drainage is usually free, continuous, and sufficient, and that once the fistulous track has been established it is not subject to those complications which arise from defective

drainage, and that even when the evidence is presented of defective drainage in the presence of a freshly formed abscess, careful scrutiny will show that it was not so much the result of defective drainage as renewed infection or reinfection of a part highly susceptible and continuously exposed to bizarre and multiform infective processes.

The state of perpetual unrest of the parts is the great predisposing factor and, on the other hand, in certain groups of cases infection is maintained *in loco* by repeated trauma, while in others reinfection takes place intermittently by the passage of fresh hosts of organisms from the neighboring bowel.

The principle of drainage is conceded to be paramount in the treatment of all abscesses that develop in the neighborhood of the rectum and executed properly would in all cases prevent the development of fistulæ. It is held, on the other hand, that in the treatment of rectal fistulæ, in order to compass their radical cure, the principle of drainage must yield to some means which will do for the relief of fistulæ what drainage does for abscess, and this brings us to the consideration of a wider application of the principle of extirpation for the cure of fistula in ano than has been heretofore considered.

It is proposed to proceed by the following steps:

1. The patient is prepared in the most careful way as for any major surgical operation on these parts.

2. The sphincter is completely dilated.

3. The internal orifice of the fistula is minutely examined and with a proper instrument is very cautiously dilated. After dilatation the mucosa is uplifted and pared with curved scissors in the direction of the long axis of the bowel, and with a small knife or fine scissors the circumference of the muscular layer is then trimmed and vivified. If need be, the opening may be incised or split in the direction of the circumference of the sphincter. After this has been done a few interrupted sutures of iodized catgut are introduced in the muscular layer at right angles with the sphincter, tied and divided. The mucous membrane is then sutured with interrupted chromic catgut or

silk sutures, properly spaced. If more than one orifice exists, of course, the same procedure is followed.

4. A flap is made on the side involved, beginning by making a small semilunar incision just beyond the border of the external sphincter, dividing the parts down to the fistulous track, the latter

FIG. 4.—Complex anorectal fistula tracking backward, branching. scheme of flap formation for adapted cases.

being divided flush at its point of emergence from the bowel. The incision is extended from both ends of the first incision outward and made large and deep enough to include, if possible, under the eye all visible and accessible branching tracks. The exigencies of the case may require sometimes the lifting of one or other of the buttocks in its entirety.

In one case, already referred to, it was necessary to make a complete flap and partial resection of both buttocks in order to reach the deepest and most distant branching tracks.

5. The opposite side of the rectal opening is now attacked, and after all doubtful tissues have been removed the rectal

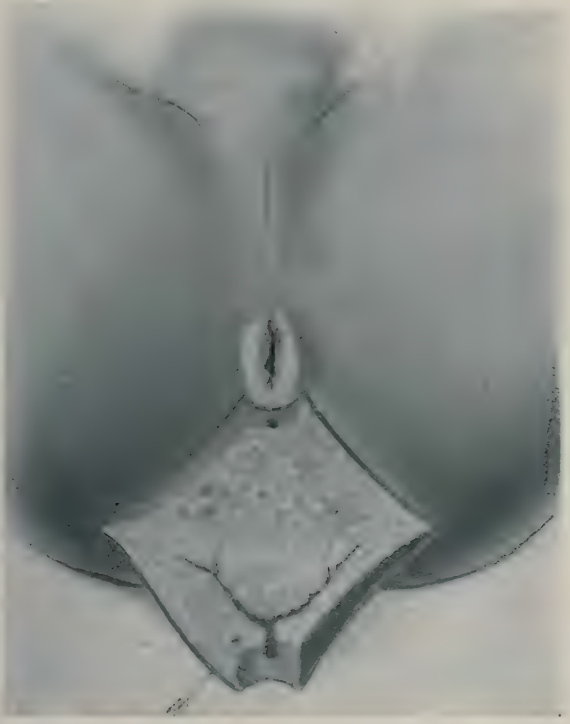

FIG. 5.—Flap reflected with contained fistulous track, preparatory to extirpation.

walls are infolded once or twice over the line of suture within. The greatest care must be exercised in removing all doubtful tissues. If need be the cautery could be used for their complete destruction, or substituted entirely for the suture of these parts.

6. The exposed flap is next attacked with knife or large pointed scissors, curved on the flat, and the original track, its

branches and the entire fistulous zone including every branching track resected. Careful search will be made in the ischiorectal fossa and perirectal spaces for any concealed tracks.

7. The whole field is then carefully flushed with normal salt solution, and, if need be, antiseptisized and the fat layers sutured with buried catgut so as to close all dead spaces. In many cases the entire wound may be closed as in the case of breast amputation, or a small drain may be left for twenty-four or forty-eight hours.

Report of Two Extreme Cases of Complete Fistula (Inveterate Forms) Relieved by this Method of Operation.

CASE I.—W. G., aged seventy years, Civil War veteran. Developed in 1863 a rectal fistula on which many operations were done from time to time, the condition becoming more aggravated.

Original examination, September, 1909, revealed a single rectal gap with numerous branches extending into the ischiorectal fossæ on both sides and over the buttocks, branching under the skin on both sides of the scrotum as high up as the groin with numerous openings discharging freely. Partial loss of control.

For relief of this case which had existed for forty-six years, both buttocks were lifted by large "trap-door" flaps and made to include as nearly as possible all branching tracks, resection of the fistula throughout the fat layers in the flaps, resection of all subcutaneous tracks with openings without. Suture of the rectum not necessary in this case. Partial resection of both flaps where tissues were unduly undermined. Replacement of the flaps by suture, closure of gaps by plastic procedure, moderate packing of open subcutaneous tracks. Complete healing of the entire area in three months. No recurrence.

CASE II.—Mrs. J. B., aged thirty-two years. Horseshoe fistula, single opening in the posterior rectal wall at the anorectal junction, tracking backward toward the coccyx and

sacrum, and branching into the fat of the gluteal folds, right and left. The condition had lasted four years.

Treated by incision on two or three different occasions. No rectal incontinence. The "trap-door" incision made behind the anus by method described, lifting the large flap which contained all branching tracks and scar tissue showing obliterated sinuses; complete extirpation of complete fistula; replacement of the flap; primary union. A slight shallow track developed for a short time, which yielded very readily to moderate use of Beck's paste.

DISCUSSION.

Dr. Thomas W. Huntington, San Francisco.

It seems to me that for many years some of the most unsatisfactory work we have done has been manifest in those cases where the fistula undermines all, or even a portion, of the sphincters. I do not believe there is a surgeon here today who has not seen some of the disastrous consequences of the ruthless division of the sphincters. I do not rise for the purpose either of confirming any observation which has been made or of offering any definite solution of this problem, but to warn against an accident which may complicate the more simple cases, those which are without upper bowel symptoms, and in which complications may give rise to an ultimate involvement of the sphincters themselves.

To put it very briefly, in the exploration of the fistula of the milder type it happens not infrequently that the probe is used without careful dilatation of the sphincter, as Dr. MacKenzie has just suggested. The probe is passed into the fistula, the finger being inserted into the rectum. After a somewhat prolonged search the end of the probe approaches the finger tip, but is separated from it by a very thin, almost tissue-paper-like covering of mucous membrane. Right here, I think, is where very serious blunders have been made—the pushing of the end of the probe into the rectum by a new channel instead of discovering the original point of departure from the rectum. I have personally been obliged to desist from examination because of lack of time and prolonged anesthesia, because this is an examination which should usually be made under an anesthetic. Of late years, since I became aware of the great advantages that ensue from thorough dilatation, I have not had so much difficulty in locating the bowel opening definitely, so that the probe may slide into it; the bowel is now exposed to the greatest possible extent in the fistulæ of lesser magnitude, and the procedure becomes one of simplicity.

Dr. Charles H. Mayo, Rochester, Minn.

Dr. MacKenzie has opened a most interesting subject. There is no question but that some of these simple cases can be treated readily by the simple procedure just described—slitting through a part of the sphincter—but the radical procedures are justifiable in cases which have not responded after several such operations. The injection of methylene blue, and more easily, of late, the use of colargol in these sinuses, is of great advantage and better than peroxide for locating the inner tract of the fistulous opening into the bowel.

Another point. In deep fistulous tracts running past the internal sphincter undoubtedly many of them connect with low diverticuli. Very recently I have seen two fistulæ from the sigmoid into the bladder due to abscess from the end of diverticuli low in the bowel, a condition which occurs more frequently than we supposed; these fistulæ sometimes form an abscess at the tip just as an appendix which ruptures into the bladder or burrows its way into the leg along the side of the bowel.

Dr. Arpad G. Gerster, New York City.

I recognize in the method proposed by the author a very valuable addition to the principles that govern the cure of these old fistulæ in ano. The principle itself is not a new one, but it has not been applied to this portion of the body before. The most valuable part of this principle is the avoidance of interference with the integrity of the sphincter and the preservation of its function. This can be done and the fistula cured by separating the trunk and branches of the fistulous system from the source of the supply of the infectious material that is in the gut. Immediate closure and the reëstablishment of the integrity of the intestinal cylinder are the salient points of the method. Therefore, if we understand the principle, as it seems to me I do understand it, then the excision of the flap containing the branching fistulæ is not the most important part of the whole procedure, but the first, the initial part, is the one which guarantees the cure. The moment the course of supply is excluded or stopped the effect ceases. This is a well-known surgical principle, and if the first step of this operation were done thoroughly, which is not always possible in the group of cases mentioned by Dr. Mayo, but is usually possible in those strictly belonging to fistula in ano, the desired result would be obtained. There are some of these cases in which the inosculation of the fistula into the intestine is so high that a surgical attack upon it will be either very difficult or impracticable. Nevertheless, I think, to come back, that the essential part having been done and successfully done, the second part, the excision, will not be necessary. I believe that then the slitting up, even if not complete, may prove to be sufficient. Even the total extirpation of the flap does not guarantee against recurrence. How does the surgeon know he has included all the branching sinuses in his flap? In this respect, the measure is no better than simple slitting.

Dr. MacKenzie. Dr. Huntington's reference to the danger of passing a probe at a given point is illustrated, I think, very well by some of my diagrams, which I had no opportunity to describe, but they convey a good deal of meaning.

I am very thankful to Dr. Mayo for his suggestion regarding colargol as a stain to identify these channels. I shall use it hereafter; I have never used any stain for such purpose, although I know that methylene blue has been used by some operators.

Dr. Gerster has given such a graphic résumé of the relation of the orifice in the bowel to the branching tracts that I feel he has illuminated my paper, and I am very thankful to him for it. I think the essential feature is the separation of the bowel from the branching tracts. Still, that is not the only important step, for it is of no less importance to remove the branching tracts in a systematic way. I have seen cases, for instance, as in the one referred to, in which there was no connection with the bowel except the divided end of the fistula, which was open, and yet complex branching had persisted for forty-six years with a persistence of infection of the parts. In this case resection was successful. I think, perhaps, the use of the cautery, as I suggested in my paper, may be suitable in place of suture in some cases.

THE CHOICE OF THE ANESTHETIC.

By ARTHUR DEAN BEVAN, M.D.,
CHICAGO.

Nitrous oxide was introduced as an anesthetic by Wells in 1844, ether by Morton in 1846, and chloroform by Simpson in 1847. Although a large number of other agents have been tried since, these three, introduced within the short period from 1844 to 1847, still remain the most valuable means of producing general anesthesia.

In 1868 Edmund Andrews, of Chicago, demonstrated the value of the mixture of nitrous oxide and oxygen as an agent for continued anesthesia. In 1884 Kohler discovered the value of cocaine as a local anesthetic. In 1899 Bier produced, by the injection of cocaine into the subarachnoid space of the spinal cord, anesthesia of the lower extremities and the lower part of the trunk. In 1869 Claude Bernard observed in experiments on dogs that morphine given before the administration of chloroform facilitated its action and reduced the amount required. This suggestion was soon put into practical use, and morphine, morphine and atropine, and morphine and scopolamine or hyoscine have since been more or less widely employed before the administration of a general anesthetic.

Today the surgeon has at his disposal the following methods of producing anesthesia:

1. General anesthesia: (*a*) Chloroform; (*b*) ether; (*c*) nitrous oxide—alone, with air, with oxygen.
2. Spinal cord anesthesia: Cocaine and similar agents.
3. Local anesthesia: Cocaine and similar agents.

4. Morphine and scopolamine, either alone or as part of a sequence.

And then these four methods have been combined in all possible ways as mixtures and sequences—as the A. C. E. mixtures, as the nitrous oxide and ether sequence or mixture, and as the morphine, scopolamine, ether sequence, etc.

During the last eight years in our surgical service at the Presbyterian Hospital and Rush College we have attempted to make a study of the subject of anesthesia, and my paper today is rather in the nature of a report of the conclusions arrived at from our own work and from a study of the literature undertaken with the purpose of aiding us in the selection of the anesthetic. The work which has been done on our service is represented by the following published reports:

"Acid Intoxication and Late Poisonous Effects of Anesthetics," by Dr. Favill and myself, published in the *Journal of the American Medical Association*, September, 1905.

"Nitrous Oxide as an Anesthetic in Major Surgery," the chairman's address before the surgical section of the American Medical Association in 1907.

"Blood Changes Incident to Surgical Anesthesia," by two of my assistants, Walter Hamburger and Fred Ewing, published in the *Journal of the American Medical Association*, November 7, 1908.

"The Effect of Ether on Certain Processes of Immunity," by Evarts Graham, fellow in surgery in our surgical department, published in the *Journal of the American Medical Association*, March 26, 1910.

"The Administration of General Anesthetics, with Special Reference to Ether and Chloroform," by Dr. Isabella C. Herb, anesthetist to our clinic, published in the *Journal of the American Medical Association*, May, 1911.

These studies briefly summarized gave us the following facts:

First, the study of Favill and myself showed clearly the late poisonous and fatal effects of chloroform associated with acute fatty degeneration of the liver. This has been confirmed by a

study of the previous literature and by the great accumulation of clinical evidence and laboratory experimentation since that time. The paper on nitrous oxide was simply intended to show its wide possibilities in major operations. The work of Hamburger and Ewing was both of a clinical and experimental research, and I regard their work of special value. Their conclusions are as follows:

In analysis of blood changes incident to nitrous oxide anesthesia we find that: (*a*) The hemoglobin is not permanently reduced nor is anemia produced. (*b*) Hemolysis is not increased. (*c*) The changes in the readings of the hemoglobin (there is an apparent increase in hemoglobin after nitrous oxide anesthesia) and the red cells are transient and of no surgical significance, and are explained on the basis of capillary stasis. The production of reduced hemoglobin is not a result of the anesthetic itself, but is due to the accompanying asphyxia. (*d*) The changes in coagulation time are not constant, but in general there is an increase in the time required for clotting, most marked about the third day.

In an analysis of blood changes incident to ether anesthesia we find: (*a*) The hemoglobin is slightly reduced; therefore, a slight anemia is produced. (*b*) Hemolysis is not materially increased. (*c*) The changes in hemoglobin and red cells are not to be explained on the basis of blood inspissation. (*d*) Ether causes a marked decrease in the coagulation time most marked from the seventh to the tenth day.

The average fell from seven minutes before anesthesia to four minutes on the seventh day. This may have an important relationship to the clinical occurrence of infarcts and thrombus a week or ten days after anesthesia. This action of ether might be beneficial in certain hemorrhagic conditions such as hemophilia and jaundice.

In chloroform anesthesia we find: (*a*) The hemoglobin is reduced and an anemia is produced. (*b*) Hemolysis is increased. (*c*) It causes a *slight* decrease in the coagulation time most marked from seven to ten days.

In a comparison of the three anesthetics from the standpoint of blood changes we conclude that nitrous oxide causes no permanent effects of any significance; that ether causes more harmful effects (slight anemia and marked decrease in coagulation time); that chloroform causes the most harmful results (hemolysis and production of a distinct anemia).

The work of Evarts Graham was undertaken as a part of a general problem on the occurrence of various postoperative lung complications in which we have been especially interested, and was directed to the study of the influence of ether on certain processes of immunity. His conclusions contained in his complete paper, published in the *Journal of Infectious Diseases*, March, 1911, are in part as follows:

1. In my experiments the phenomena of bacteriolysis and agglutination were unaffected by ether.

2. Ether as given for anesthetic purposes reduces the property in human and rabbit blood of promoting phagocytosis of streptococcus, pneumococcus, staphylococcus, colon and typhoid bacilli. This effect is easily studied in vitro.

3. The period of depression of phagocytosis after ether anesthesia is variable, depending on many factors.

4. This reduction is apparently due to a direct action of the ether on the serum and leukocytes.

5. The explanation of this action of ether is not clear, but the experiments suggest the possibility of its being due to the fat-solvent power of ether.

6. Lecithin in small amounts in vitro and also when given subcutaneously counteracts the inhibitory effects of ether.

7. Olive oil in vitro and in vivo when given per rectum seems to exert the same effect as lecithin in counteracting the inhibition of phagocytosis produced by ether, but to a less degree.

The recent paper by Dr. Isabella Herb is a practical one on the administration of general anesthetics, and is, on the whole, a plea for simple uncomplicated methods of anesthesia, and for placing this important part of surgical work in specially trained hands, a position to which I am thoroughly converted.

From these special studies and from a review of the literature, we shall attempt to draw conclusions which will assist in the selection of anesthetics.

In regard to the immediate safety and deaths on the table, we find in Hewitt's work on anesthetics that in over 1,000,000 reported anesthesias the following results occurred:

	Cases.	Deaths.	Death rate.
Chloroform	676,767	214	1 to 3,162
Ether	407,553	25	1 to 16,302

In 80,255 anesthesias at St. Bartholomew's, in London, from 1875 to 1890, there were:

	Cases.	Deaths.	Death rate.
Chloroform	42,978	33	1 to 1300
Ether	37,277	4	1 to 9319

Hewitt believes from his studies that ether is about six times as safe as chloroform. From the standpoint of immediate danger, therefore, the evidence is conclusive that no surgeon or anesthetist has the moral right to use chloroform in preference to ether unless in the special cases there are special and peculiar conditions which make the use of chloroform in that special case safer for the patient. The greater immediate danger of chloroform has been for a long time recognized and admitted even by its advocates. Until comparatively recently, especially within the last five or six years, the champions of chloroform claimed that this greater immediate danger of chloroform was more than offset by the fact that chloroform produced no bad after-effects, and that whereas chloroform killed some on the table, ether killed more in the week or ten days following anesthesia from ether nephritis and ether pneumonia. Let us analyze this claim.

The facts in the present state of our knowledge seem to be that both chloroform and ether can produce injurious effects upon the kidneys, and the evidence seems to show that chloroform is just about as injurious to kidney tissue as is ether.

A more careful study of the so-called anesthetic pneumonias

which we have made on our service has led to the conclusion that many of them are independent of the general anesthetic employed, and should be called not anesthetic pneumonia, but postoperative pneumonias. For instance, Mikulicz found that in one hundred operations on the stomach done under local anesthesia with cocaine there were as many or more resulting pneumonias than occurred in another series of one hundred done under a general anesthetic. I think one can now say that for the most part, postoperative lung complications are autogenous infections; that, as Dürk has shown, the patient carried the specific germ cause about with him before and at the time of operation, and that traumatism or chilling and lowering of the vitality and the resistance, as Graham has shown in the fall of the opsonic index, is the factor responsible for the development of the pneumonia. In the hands of an expert anesthetist and with proper precautions against chilling, etc., there is in my opinion little if any more risk of pneumonia after a properly conducted ether anesthesia than after a chloroform anesthesia. On the other hand, it has now been shown that the late serious poisonous effects of chloroform on the liver are common, at least by no means rare, and that they are often fatal.

Our studies of such postoperative complications as femoral thrombosis, lung infarcts, and pulmonary embolism seem to show that these complications are the result of trauma and low-grade infections, and independent of the anesthetic employed. Rosenow on Dr. Billings' service, found in three cases of postoperative thrombus and embolism a pneumococcus of low virulence with which he succeeded in producing similar thrombi in animals. In this connection the very interesting fact demonstrated by Hamburger and Ewing must be further investigated, *i. e.*, that ether produces a more rapid coagulation of the blood, from seven to four minutes, most marked from the seventh to the tenth day.

Looking at this subject of the late injurious effects of general anesthetics as a whole, including postoperative lung and kidney complications and fatty degeneration of the liver from chloro-

form, I think we must conclude that the secondary late bad effects are quite as numerous and more serious after chloroform than after ether. If these facts are true, chloroform has no longer any claim to recognition except in special cases.

Nitrous oxide, until comparatively recently, has been in the hands of the dentists for short anesthesia, although as already referred to, Edmund Andrews showed as early as 1868 that it could, in a mixture with oxygen, be used for long anesthesias. In the last five years nitrous oxide has been used more and more in this country. It has had great vogue and has become a fad in the hands of some men who have advocated it as the routine anesthetic in surgical work. Let us attempt to weigh the evidence and assign to nitrous oxide its proper place.

Nitrous oxide for short anesthesia is the safest anesthetic agent known. It has a very considerable field of usefulness, and I think that it can very properly be said that a surgical clinic which does not find frequent use for nitrous oxide is, from the standpoint of anesthesia, a badly conducted surgical clinic. In the setting of fractures, in reducing dislocations, in opening abscesses, in breaking up adhesions, in many minor operations of short duration, it is clearly the anesthetic of choice. In longer operations which must be done in patients with impaired kidneys, where the possible irritation of the kidneys by chloroform or ether must be avoided, nitrous oxide with air or oxygen offers us the safest anesthetic. In patients who are extremely bad surgical risks, as in typhoid perforation, grave general peritonitis, intestinal obstruction, etc., it frequently is the safest anesthetic and is to be selected.

On the other hand, I am of the opinion that patients with bad heart lesions, with broken compensation, are not good subjects for nitrous oxide, as I have heard of a number of deaths in this class of cases, and I believe that in such cases ether, if properly given, is preferable.

The effort to make nitrous oxide and oxygen the standard anesthetic in a surgical clinic is to my mind ill-advised. Nitrous oxide is far from being an ideal anesthetic. It does not produce

in many cases sufficient relaxation, it is uneven in its action, and in some cases the anesthesia is not complete and the surgeon is required to work at a disadvantage. In the ordinary case where the patient is a good surgical risk a properly given ether anesthesia is quite as safe for the patient, and much more satisfactory for the surgeon, than nitrous oxide.

In this connection I should like to protest against the complicated expensive apparatus for nitrous oxide, oxygen, ether, and chloroform sequences and mixtures which are now being foisted on the market by instrument makers. They are too complicated and cumbersome. It would be necessary only to add to some of these a carburetor and a magneto, and you would have a 1911 model. The simple cheap stands for gas tank and face mask are much to be preferred.

Local anesthesia has a considerable field of usefulness. In minor operations on the extremities, where the blood supply can be controlled with a rubber bandage; in circumcision, especially in the adult; in some special operations like ligating arteries in exophthalmic goitre; in tracheotomy, for carcinoma of the larynx, and occasionally in hernia operations, especially strangulated hernia, with the patient in bad condition, local anesthesia often becomes the anesthetic of choice. In doing any considerable operation under local anesthesia it is well to give the patient $\frac{1}{6}$ to $\frac{1}{4}$ of morphine and $\frac{1}{150}$ to $\frac{1}{100}$ of hyoscine a half-hour before the operation, and the solution which I have found very safe and satisfactory for the infiltration is $\frac{1}{1000}$ cocaine in normal salt with 1 minim of $\frac{1}{10000}$ adrenalin to each 100 minims of the solution. In the majority of these operations less than 100 minims, which represents less than $\frac{1}{10}$ grain of cocaine, is sufficient, and in this amount cocaine is perfectly safe.

Spinal anesthesia to my mind has little or no field of usefulness. It is dangerous, it is often incomplete, it is often necessary to use ether or some other general anesthetic to finish the operation. The after-effects, such as vomiting, headache, and the symptoms of the so-called aseptic meningitis, are often severe

and distressing. The statistics show that 9 deaths occurred in the first 1000 cases. From what I know of the evidence on spinal anesthesia, and from what I know of the anatomy of the spinal cord, I would under no circumstances which I can now conceive of choose spinal anesthesia for my own case if I required a surgical operation. The fiasco of Jonnesco in this country a short time ago was a strong argument against spinal anesthesia. After Jonnesco's spectacular demonstration at the Cook County Hospital, in Chicago, some of the attending surgeons tried the method in a few cases. The fifth case, a simple fracture of the patella, died from a moderate dose injected in the mid-lumbar region. It is an interesting physiological and pharmacological fact that anesthesia can be produced by spinal injection of cocaine, stovain, etc. It is too dangerous and too unsatisfactory a method to ever supplant our present methods of anesthesia. It should be limited to an exceedingly small field. I am quite in accord too with Keen's statement: "The ideal anesthetic will not be one which will abolish pain without abolishing consciousness. To have the patient aware of surgical emergencies which test even a veteran operator's skill and resources to the utmost would frequently invite death by the terror which it might occasion. The ideal anesthetic will abolish pain by the abolishment of consciousness, but without danger to life."

What of scopolamine and morphine? In the early work with this combination several years ago, where complete anesthesia was sought from these agents alone, the mortality was so great that the method was soon abandoned and the method remains now with us simply as the first part of some sequence, such as the morphine, scopolamine, and ether, or the morphine, scopolamine, nitrous oxide, and ether sequence.

My anesthetist, Dr. Herb, after an experience in more than 20,000 cases, protests against the routine giving of drugs before ether or chloroform anesthesia. She says: "In selected cases it may be of value, but the use of morphine with atropine or hyoscine (scopolamine) is absolutely detrimental in many instances. It is a well-known therapeutic fact that one drug

may augment the action of another, and this is especially so in the morphine-scopolamine-ether or chloroform combination. Consequently, an overdose is more easily administered. In case of any untoward accident there is not only the volatile and quickly removable drug, but also the non-volatile and comparatively permanent one to be eliminated.

"Not the least of the objectionable features of drugging before general anesthesia is the masking of the most valuable of all guides in anesthesia—namely, the pupillary reaction. Morphine allays the reflex excitability of the air passages, retards coughing, favors the retention of aspirated blood or vomitus in the trachea which predisposes to pneumonia. Many people are not able to take morphine without distress and vomiting, and in such individuals the disagreeable after-effects of ether would be aggravated."

The giving of the anesthetic in a surgical operation is a very important function, and it should be in competent trained hands. A thoroughly qualified professional anesthetist is an indispensable member of a modern surgical team. In this country we have too long left this important function in the hands of the junior interne. The difference between the safety of the patient and the comfort of the operator in a clinic in which the anesthetic is in the hands of a trained professional anesthetist, as compared to a clinic in which the anesthetic is in the hands of a junior interne, whose term of office is but a few months, is so enormous that one who has had the services of a skilled anesthetist would never voluntarily return to the unskilled interne anesthetist.

Every hospital should have trained professional anesthetists. The internes should be instructed by the professional anesthetist and they should give many anesthetics under supervision, so that they can learn how an anesthetic should be given, and in a teaching hospital senior medical students should be given practical instruction in the use of anesthetics, but the trained anesthetist should be present and responsible for the anesthesia.

Women, I think, make the best anesthetists, just as they make

the most reliable and conscientious operating-room nurses. In these days of modern surgery the responsibilities and the functions of the skilled anesthetist and the head surgical nurse are little less important than those of the operator himself.

In answer to the question, How are we to secure the safest and most satisfactory anesthesia? I would from this study submit the following conclusions:

1. The anesthesia must be placed in trained professional hands.

2. The methods of giving the anesthetic and the apparatus employed should be as simple and uncomplicated as possible.

3. The anesthetic mixture and sequences should be like the old shotgun prescription of the past—avoided—and the patient's life not jeopardized by the exhibition of two or more powerful poisonous agents at the same time which might intensify, one the action of the other, or mask the ordinary danger signals.

4. For routine work ether by the open or drop method is the safest and most satisfactory anesthetic, and in the usual run of cases who are good surgical risks in a hospital service it is the anesthetic of choice in from 75 to 80 per cent. of the cases.

5. Chloroform must be discarded as a routine anesthetic. It produces too many immediate and late deaths to warrant its general employment. It is only in the exceptional case, as possibly in a laryngectomy, where it might be difficult to maintain anesthesia with ether after the trachea had been opened or divided, and where one might feel that the direct introduction of chloroform vapor into the trachea might produce sufficiently less irritation to the tracheal mucosa with less risk of pneumonia than ether, that we would be warranted in employing it.

6. Nitrous oxide is the anesthetic of choice for short operations, manipulations, and examination. It is also the anesthetic of choice in operations on patients with seriously impaired kidneys, and often in cases in extremely bad condition, as typhoid perforations, general peritonitis, etc. It should not be employed in patients with bad hearts. It is not as satisfactory an anesthetic as ether, and it should not be employed in preference to

ether in the ordinary prolonged operation in patients who are good surgical risks.

7. Local anesthesia with cocaine and similar agents has a limited field of usefulness. The amount of cocaine employed by infiltration should always be short of a toxic dose, $\frac{1}{10}$ to $\frac{1}{4}$ grain. It should be employed in normal salt solution with small amounts of adrenalin. Where the amount does not exceed $\frac{1}{10}$ grain it may safely be preceded by a small dose of morphine and scopolamine.

8. Spinal cord anesthesia has today little or no place in surgery.

9. The use of morphine and scopolamine before a general anesthetic brings with it dangers which are not compensated for by any advantages, and the method should be abandoned or limited to specially selected cases.

10. I believe that the time has come when we must here in America make a place for the trained professional anesthetist on our surgical team.

CHLOROFORM ANESTHESIA.

By JAMES E. MOORE, M.D.,
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When young people get far enough along life's journey to have religious opinions, these opinions are rarely based upon conviction or reason, but are a matter of inheritance. They usually accept the religion of their parents without question. So it is when a young man enters the medical profession with regard to his choice of anesthetic. He does not deliberately study the relative merits of the various anesthetics and choose the safest and best, but he chooses the one his teachers used. In England he usually chooses chloroform, while in America he more often chooses ether. In other words, he chooses the popular anesthetic. For over thirty years I have been a dissenter, and have used chloroform instead of the more popular ether which all of my teachers used, with one notable exception. I hope to add interest to the discussion of anesthesia at this meeting by telling why, after using chloroform for all of these years with success, I am now using ether.

The change was not made because of deaths or misfortunes from the use of chloroform, for I never had a death on the table or immediately after leaving it that could possibly be attributed to the anesthetic. One death from acute yellow atrophy occurred three days after a simple appendectomy, but it is impossible to demonstrate that the death would not have occurred had the patient taken any other anesthetic or no anesthetic. We have in the University two specimens of acute yellow atrophy of the liver removed by Dr. Corbett from persons who had died after operations in which ether was the anesthetic, the histories of

which I have attached to this paper. It is a common practice to attribute deaths occurring soon after operations to the anesthetic. This is often done when it is very evident to everyone but the operator that the operation was directly responsible for the death. The mere fact that a patient dies during or soon after an operation from unknown causes is no proof that the anesthetic caused the death, but it usually gets the blame, especially when the unpopular chloroform has been used. It has been aptly said that it is important to differentiate between death from an anesthetic and death during anesthesia. I have known of an instance in which the patient bled to death after a throat operation, and in which the anesthetic was held responsible.

My original choice of chloroform was due to the fact that ether as administered in those days was a very disagreeable anesthetic. The patient was smothered in the drug, and after struggling and growing black in the face for a considerable length of time, became unconscious only to awaken suffering from extreme nausea and vomiting. On the other hand, Lewis A. Sayre (peace to his ashes) would come into the amphitheatre, pull a small vial of chloroform out of one pocket and a handkerchief out of another, place the folded handkerchief over the patient's face, drop the chloroform on the handkerchief, and usually without a struggle, and in a very short time, the patient was sleeping quietly, and the after effects were usually very much less uncomfortable. Had ether been given then by the drop method, as it is now and as chloroform was then, I doubtless would have chosen ether, because it is a safer drug. I am firmly convinced, however, that the dangers of chloroform, as well as other anesthetics, are more in the anesthetizer and the method of administration than in the anesthetic. The immediate cause of my change of anesthetic was the loss of my anesthetist, who had administered chloroform safely for me for many years.

Most deaths from chloroform have been caused by giving too much of the drug.

Most American writers on anesthesia claim that ether is the chosen anesthetic of the vast majority of doctors in this country.

This is undoubtedly true in the large cities, but it is not true in the country districts of the Northwest. For twenty-five years I have performed operations in the country from Michigan to Arizona, and in every instance the anesthetic chosen by the local doctor was chloroform. The reason for this is very plain. Chloroform being the stronger drug, puts the patient to sleep quickly, quietly, and with a small quantity of the drug given by the drop method, while ether given by the old method was slow, disagreeable, and very often inefficient, the patient struggling during the operation. With our present method of administering ether by the drop method on an Esmarch inhaler, such as has been used for chloroform for many years, it is safe, comfortable, and efficient. Our custom in the Northwest of having trained nurses act as anesthetists is made possible only by our improved methods of administering ether, for it is too great a responsibility to allow any one but a graduate in medicine to give chloroform. I have known of several deaths from ether, and of a greater number from chloroform during my professional career, and in every instance the anesthetizer has been untrained and inexperienced. The immediate cause has usually been an overdose of the drug. It is an easy matter to kill an animal by giving a sufficient quantity of either ether or chloroform, but the latter being the more powerful drug acts more quickly.

Most of our differences of opinions and experiences have been due to our methods of administration rather than to the drugs themselves. In 1886, when I returned from Germany, I brought with me a number of Esmarch's inhalers and a trained anesthetist. At that time, so far as I know, only one other surgeon in Minneapolis besides myself had the courage to use chloroform, because of its supposed danger, but after this trained anesthetizer, whom I loaned to many of my colleagues, had remained one year, almost every doctor in the city carried an Esmarch inhaler and a bottle of chloroform in his bag. They still carry their inhalers, but since we have learned to administer ether by the drop method, most of them, like myself, carry a small can of ether instead of chloroform. At the time mentioned

it was necessary to carry such a large amount of ether and such a cumbersome inhaler that an extra bag was required for them.

The important lesson to be learned from my experience is that instruction in the administration of anesthetics should hold a very prominent place in our college curriculum. Many deaths have been due to our neglect of this matter in the past, and at present the subject is not taught as it should be. Unless a graduate from any of our colleges has served a term as interne and gained his experience during that term, he is untrained, and unfit for an anesthetizer.

We feel that we have solved the problem of anesthesia in the University and the Northwestern Hospitals, with which I am connected, by having specially trained nurses, who are paid a salary, and are taught to administer ether by the drop method. We first tried salaried graduates in medicine, but in a very short time their time became too valuable for them to remain with us at a salary we could afford to pay, and the result was frequent changes. All students entering the College of Medicine of the University of Minnesota in future will be obliged to erve a fifth or clinical year as interne in the University, or some affiliated hospital, before he receives his degree, and proper training as an anesthetizer will be an important part of that year's work.

To recapitulate: My reasons for changing to ether after more than thirty years of satisfactory experience with chloroform are:

1. Chloroform is a powerful drug that should be administered only by graduates in medicine who are specially skilled in its use, and these trained anesthetists are not always at hand.

2. Should a death occur from chloroform the surgeon would be more severely criticised because it is the more dangerous and the more unpopular anesthetic.

3. The most important reason is that since we have learned to administer ether by the drop method it is not only safe, but it is comfortable and convenient, and the former advantages of chloroform have disappeared.

Case I.—The case is that of a man who had been run over forty-eight hours before death and the left arm had been cut

off by a car-wheel. Following the accident there occurred profuse and uncontrollable hemorrhage. The patient was brought to the Asbury Hospital, given ether, and an amputation stump made of the remaining portion of the arm. Attempts were made to resuscitate the patient by the use of normal salt. Following the operation the patient's pulse increased in rapidity, he became very pale, and delirium developed rapidly. He lived thirty-six hours after the operation.

External Appearance. Body is that of a well-developed and well-nourished man. There is a large ecchymosis on the front of left shin two inches above internal malleolus. There is absence of left arm and an amputation wound in which there has occurred practically no repair. The bone is about four inches long, and covered with skin only. In places this shows evidences of trauma. The wound is left with free drainage. There is no pus or any evidence of infection. The flap of the stump is derived from the skin of the inner part of the arm. The fat in the flap appears matted and compressed.

On making the median incision the muscles of the abdomen and thorax appear red and practically normal.

Peritoneal Cavity. The omentum lies over the entire anterior abdominal surface. The large and small bowels are distended with gas, appear empty, and have a translucent look, with occasional small mottled areas. The mesentery is thickened with fat, and the veins are practically free from blood. The outer surface of the bowel also has a whitened, anemic appearance. The sigmoid is bound down to the parietal peritoneum by old adhesions containing well developed bloodvessels. These adhesions cause the sigmoid to take an S-shaped course, in addition to the usual position of that organ. The liver occupies a normal position. The appendix is very long, and has an individual mesentery springing from the anterior surface of the mesocolon. The result of this is to draw the appendix over nearly to the median line. The diaphragm occupies a normal position and does not present any evidence of inflammatory change. Mesenteric lymph nodes in lower end of bowel are slightly hyperplastic.

Pleural Cavities. The left cavity is free from abnormal fluid or adhesions. The right lung is bound down over the entire pleural surface by old organized adhesions.

Pericardial Cavity. Normal.

Heart. Extremely flabby in consistence, and apparently of about normal size and weight. The muscle appears pale and somewhat brown on section. Root of aorta normal.

Lungs. On outward surface pale grayish in color. There is no evidence of any consolidation in either lung.

Spleen. About normal in size. On section it is somewhat more pale than normal in color.

Liver. Weighs 2000 grams. It appears pale, both on external surface and on cut section, its pale buff color being mottled with small areas that are almost white. Around the gall-bladder there is some slight staining of the tissues, due to postmortem changes. There are old firm adhesions between the liver and spleen. The gall-bladder is full of fluid bile. The ducts are patent.

Pancreas. Apparently normal.

Gastro-intestinal Tract. The stomach is normal except as to color, it being paler than normal, on both peritoneal and mucous surfaces. The walls of stomach and intestines seem to be thinner and more translucent than normal.

Adrenals. Right adrenal is small. Left is somewhat larger than right and consists of a flat, thin plate of adrenal tissue.

Kidneys. Normal in position and size, weighing 125 grams. They appear pale and flabby in consistence. The long diameter is relatively increased. On section cortex is rather thin, pale in appearance, and the glomeruli are not well marked. Cortex is slightly striated. This description applies to both kidneys. Ureters are normal in appearance, but differ in their anatomical location, the right crossing the iliac vessels further away from the median line than the left.

Aorta. Normal.

Lymph Nodes. Normal.

Organs of Neck. Not examined.

Head. Brain is anemic in appearance and the vessels almost empty of blood.

Diagnoses. (1) Anemia. (2) Acute fatty degeneration of liver. (3) Changes in heart muscle (brown atrophy?). (4) Old healed pleuritis. (5) Old healed peritonitis.

Microscopic Examination of Liver. Complete fatty change.

CASE II.—Patient was a woman, aged thirty years. Had been operated upon for cholecystitis, appendectomy, resection of right ovary. On leaving the table pulse was 110. This continued to increase in rapidity, patient became very nervous, finally became jaundiced, and died thirty-six hours after the operation.

On postmortem the following conditions were found:

Heart. The heart was arrested in systole. Of small size and heart muscle brown in color.

Lungs. Normal.

Peritoneal Cavity. There was a small amount of serous exudate in the gall-bladder region. Intestines in gall-bladder area were slightly matted together. In other localities no stickiness or adhesions. Adhesions in region of gall-bladder are fibrinous and very recent.

Uterus. Is in normal position. The right ovary had been resected, and the appendix removed. There were no blood clots free in the abdomen.

Gall-bladder. Was nicely adherent to the parietal peritoneum and contained a large red drainage tube. There was no evidence of leakage about this drainage tube.

Liver. Was extremely small and presented on superior surface several bright yellow areas. The areas occupied about two-thirds of the liver substance, and extended into liver by numerous irregular branches and arms. The veins of capsule give the yellow areas a mottled appearance.

Autopsy Diagnoses. (1) Acute degeneration of the liver following ether. (2) Recent operation wound.

Bacteriological Examination. Cultures from the peritoneal cavity showed streptococci of very low grade of virulence. Cultures from liver were negative.

THE USE OF REBREATHING IN THE ADMINISTRATION OF ANESTHETICS.

By W. D. GATCH, M.D.,
BALTIMORE.

Since the very introduction of ether and chloroform the use of rebreathing in administering them has been under discussion. With chloroform it has seldom been permitted, while with ether, until recent years it was considered desirable,[1] and ether was given almost exclusively by means of a closed inhaler of some sort. Since the introduction of the open method of etherization, however, rebreathing has fallen into disfavor, and writers now pretty generally condemn it.[2] It is my purpose to show, that, contrary to this common opinion, rebreathing when properly regulated, and when the oxygen supply is ample, is harmless, and can be put to a valuable use. The evidence in favor of this is derived partly from a series of 2500 gas-oxygen, and gas-oxygen-ether anesthesias given by a closed method at Professor Halsted's clinic, and partly from the recent and very important work of the physiologists—Henderson,[3] Hill,[4] Haldane,[5] and others—on the carbon-dioxide metabolism of the body. In a preceding paper[6] I have discussed the use of rebreathing in giving nitrous oxide with oxygen; here I wish to consider its use in administering any inhalation anesthetic and more especially ether.

We can approach our subject most simply by considering the harmful results supposed to follow the administration of ether by the use of closed masks. I shall speak only of ether for the present, because most of the investigations bearing on the question of rebreathing have had to deal with this anesthetic. The ill effects in question may be grouped under two heads: (1) Injury

to the lungs. (2) General toxic effects. Dresser,[7] Offergeld,[8] Poppert,[9] and Hölscher,[10] have studied very carefully the effects of ether vapor upon the respiratory passages. Dresser regards any concentration of ether vapor which cannot be inhaled by the patient while in the conscious state without discomfort and coughing, as harmful to the lungs. Applying this test, he fixed upon 6 per cent. to 7 per cent. as the highest concentration which should be used. Offergeld, experimenting upon animals, found that the lungs after etherization by a closed method, showed much graver injuries than after etherization by an open method. With the closed method he found extensive fatty degeneration and desquamation of the epithelium of the air passages, also many minute hemorrhages into the alveoli; many of the animals died of bronchopneumonia. With the open method the pulmonary lesions were of a comparatively unimportant character, unless the administration was frequently repeated at short intervals. Poppert, whose experiments were similar to Offergeld's, concluded that ether vapor is more irritating to the lungs the greater its concentration. Hölscher studied the distribution of secretion in the air passages during ether narcosis. He found that there is only a very slight secretion from the epithelium situated below the level of the larynx. He proved that mucus and saliva may be aspirated into the deepest air passages by putting coloring materials into the mouths of anesthetized animals. His conclusion was "that affections of the air passages occurring after ether are for the most part due to the aspiration of infectious mouth contents."

We can summarize the experimental results dealing with the effects of ether vapor upon the lungs as follows: The irritant action of the vapor varies according to its concentration; postoperative lung complications are frequently caused by the aspiration of mouth contents. The greater severity of the pulmonary lesions found after experimental etherizations by the closed method can be satisfactorily accounted for by the great concentration of ether vapor in the closed masks, and the greater liability to aspirate mouth contents when these are used.

We have now to consider why the general toxic effects which follow ether anesthesia are more severe after the closed method than after the open method. Writers are almost unanimous in asserting that they are so. The work of Ladd and Osgood[11] is very important in this connection. These authors studied the frequency of post-anesthetic vomiting in patients after etherization with the Blake cone and in those etherized by their "gauze ether" method. Vomiting was much more frequent and severe among the former patients than among the latter. With the Blake cone cases they found acetone in the urine after operation in 88 per cent. of the cases, while with the "gauze ether" cases they found it in only 26 per cent. The technique and advantages of the open method are discussed by Miss MacGaw,[12] who reports 14,000 cases with most satisfactory results. In short, there is no doubt that this method of etherization is better than the rather crude closed methods it has replaced. Of its disadvantages and dangers I shall speak later.

To what causes are the ill effects which follow the closed method to be traced? The causes commonly held responsible therefor are the following:[13] (1) Anoxemia, (2) overconcentration of ether vapor, (3) toxic organic substances in the expired air, and (4) excess of carbon dioxide in the expired air. The first and second of these possible causes are, I believe, the real ones. The third is imaginary, since the physiologists have demonstrated, beyond any reasonable doubt, that there are no organic poisons in the breath.[14] Concerning the excess of carbon dioxide, it is the purpose of this paper to show that it is harmless and can be put to a valuable use.

It is perfectly evident that anoxemia and overdosage of ether, evils almost unavoidable when this anesthetic is given in a tightly closed mask, must do harm. We know that a deficiency of oxygen will quickly cause the gravest injuries to the tissues. Dresser found that the gas within closed etherizing masks would, at times, put out a burning candle. He also found that the ether vapor within the closed masks sometimes reached a concentration as high as 34 per cent., while 6 to 7 per cent. is

the greatest concentration which can be inhaled without irritation to the air passages. With such an overdosage of ether as this, it is true that the excess of carbon dioxide within the closed masks is injurious, for it stimulates powerfully the respiration and leads quickly to an overabsorption of ether by the blood.

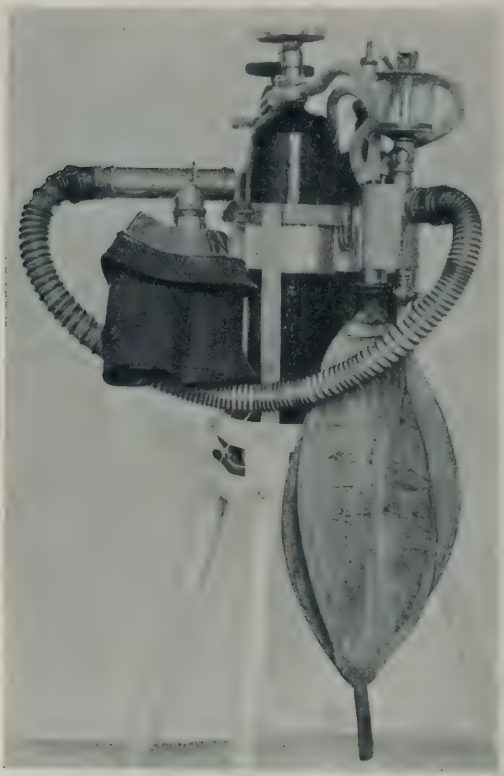
If the truth of what has just been stated be admitted, it follows that if we can prevent anoxemia, overconcentration of vapor, and too great a depth of anesthesia, we can obviate most of the serious objections to the closed method of giving ether.

I have so far limited the discussion to the administration of ether, but it will apply in part, at least, to all anesthetics given by inhalation—to chloroform, ethyl chloride, and nitrous oxide. With all of these it is evident that anoxemia must be prevented. With chloroform and ethyl chloride, on account of their great toxicity, overdosage is the most important problem in administration. With nitrous oxide, in the absence of asphyxia, overdosage is impossible. Ether requires a special consideration on account of the peculiar irritant action of high percentages of its vapor on the air passages.

I have made use of the principles laid down in the foregoing paragraphs in developing a method of anesthesia, the technique and advantages of which I now wish to describe. Nitrous oxide and, if necessary, ether, are the anesthetics used. The apparatus* employed consists essentially of a mask connected by a piece of flexible tubing to a rubber bag. This forms a closed space into which the patient breathes. On the mask is a valve-box by means of which he can be made to breathe to and fro into the bag, or to inspire from the bag and expire into the air, thus emptying the bag. The bag is attached to a small box through which the current of gas must pass back and forth from the bag to mask. Into this box nitrous oxide and oxygen are

* I have already described the apparatus elsewhere in some detail (reference 6). It will be noted that the arrangement for giving ether has been changed so as to permit of a more accurate dosage. The method of administration is practically unchanged except that we now allow rebreathing for somewhat longer intervals.

admitted, and ether, drop by drop, from a receptacle above. The ether is vaporized in the box from a series of drip plates, and any excess of ether can be drained off at will by a stop cock. The mask is adjusted carefully to the patient's face, and the bag filled with nitrous oxide with a very small amount of oxygen.



The apparatus.

The patient is made to breathe this mixture in and out through the valves. He thus replaces all the air in his lungs with nitrous oxide and oxygen. The bag is next refilled with the same mixture of gases which the patient is now made to rebreathe continuously for from four to five minutes. At the end of this time he is

allowed to empty the bag, breath by breath, into the air, after which it is refilled and the same procedure is repeated. Oxygen is given, without any attempt to estimate its exact percentage to the nitrous oxide, in quantities just sufficient to keep the patient's color free from cyanosis. If desired, nitrous oxide can easily be given under positive pressure, by keeping the bag slightly overdistended. This is sometimes a useful procedure in managing difficult cases. Anesthesia is usually established in less than two minutes. If the anesthesia is unsatisfactory with nitrous oxide alone, ether is added. This combined nitrous-oxide-ether anesthesia has many points of practical and scientific interest, and calls for a special consideration.

Ether is not given till the patient's respiration has been stimulated by the accumulation of carbon dioxide which results from the rebreathing. It is then added drop by drop. The heated gases quickly evaporate it from the drip plates, and it is rapidly absorbed by the blood because of the increased pulmonary ventilation. The most difficult subjects can thus be deeply anesthetized.

I have already referred to Dresser's experiments in which he proved that 6 to 7 per cent. of ether vapor is the greatest concentration which can be inhaled by a patient in the conscious state without irritation and coughing. Precautions must be taken to keep the concentration of ether vapor in the mixture of gases below this level if we wish to do away with any possibility of injuring the lungs. This is quite easily accomplished, as the following simple calculation will show. The gas bag moderately distended holds about 10 liters of gas, the mask and tubing hold about 1 liter, and the entire respiratory system of the patient holds about 3 liters. When the patient is rebreathing these, all form one closed space, with a total capacity of about 15 liters. Our problem is then simply this: How much ether must be added to 15 liters of gas to make the concentration of ether vapor 6 per cent.? Professor Abel has very kindly performed this calculation for me and gives the amount of ether as 4.2 c.c.

He desires me to state, however, that the conditions of the

problem are so variable that the amount of ether required cannot be determined with absolute accuracy. The varying temperature in the apparatus, the loss of ether through leaks, and by absorption in the lungs, are factors for which no accurate data can be furnished. But absolute accuracy is not necessary, because the constant loss of ether gives us a wide margin of safety, so that we can probably add ether much faster than our calculation allows without exceeding the danger limit.

With the drops of ether falling at the rate of 120 to the minute, I have found that it takes two and one-quarter minutes to add the 4.2 c.c. Therefore, if we give ether at this rate, and take the precautions not to keep it dropping for more than two minutes at any one time, and to keep the bag constantly full of gas, we can be sure that the ether vapor will not reach a concentration greater than 7 per cent. If the anesthetist does not care to follow some such rule as this, he can easily, and I think with perfect safety to his patient, estimate the strength of ether vapor by its odor as it escapes from the valve box. In fact, ether is used for so short a time, that even if it were administered in a somewhat concentrated form it would probably do no harm.

It has been found unnecessary to give ether constantly during the administration. When enough has been given to produce satisfactory anesthesia, the same can be maintained with nitrous oxide alone, even in cases requiring a deep narcosis. This is to be explained by the fact that the rebreathing prevents the ether once dissolved by the blood from being thrown off as rapidly as it would otherwise be by the lungs, which are the organs by which it is practically all eliminated.[15] Suppose, for example, that a patient having a certain amount of ether dissolved in his blood, be given some fresh nitrous oxide and oxygen to rebreathe. The ether will be thrown off from his lungs until the tension of its vapor in the gases being breathed will equal that in the blood. When this occurs no more ether will be eliminated until a new supply of gas be furnished.

Not only can we prevent the elimination of ether by rebreathing, but we can also hasten the same by a rapid ventilation of

the lungs with fresh gas. During the process of rebreathing, carbon dioxide accumulates in the body and stimulates the respiratory centre so that the breathing becomes deep and rapid—often 50 or 60 respirations to the minute. When a patient, anesthetized in the way I have described, and breathing at such a rate, is given a fresh supply of gas, and allowed to discharge each breath into the air, he apparently rapidly rids himself of the small dose of ether he has been given. Thus it is possible to anesthetize a patient so deeply that he will not stir during a Whitehead operation, and yet have him conscious before leaving the operating room. By careful administration we can, in most cases, keep the patient from knowing that he has been given any ether at all, so complete and rapid is its elimination.

I would suggest that this method of removing a volatile anesthetic by rapid ventilation of the lungs be used at the close of every administration of chloroform or ether. The increased pulmonary ventilation can be easily brought about by making the patient breathe in and out through valves, air or oxygen containing a small percentage of carbon dioxide. I have had such a mixture of oxygen and carbon dioxide prepared, which contains 7 per cent. carbon dioxide, but have not had the opportunity to give it a clinical trial.

In this connection it is interesting to consider the effect which morphine has upon the elimination of ether or chloroform from the body. Morphine decreases markedly the rate of pulmonary ventilation.[16] Large doses of it must, therefore, retard the elimination of the anesthetic and thus increase its toxic action. It is often possible to detect the odor of ether or chloroform on the patient's breath for several hours after operation. This slow excretion may be due, in part at least, to the morphine, a hypodermic of which is necessary before or after almost every anesthesia. Perhaps this effect of morphine can be prevented by means of the method I have just described for quickly eliminating the anesthetic.

In the preceding paragraphs I have discussed how ether can be safely introduced and speedily removed from the patient's

system. During its stay therein we are powerless to prevent its toxic action. By giving it, however, in combination with nitrous oxide and morphine we can reduce its dose, and therefore its ill effects, to the minimum, since the major portion of the anesthesia is produced by the other two drugs. It is probable also that the effect of ether when thus administered with other narcotics is relatively much greater than when given alone, as it is a well known principle of pharmacology that narcotic drugs given in combination reinforce one another's action.[17] Thus the powerful joint effect of morphine and hyoscine is explained.

I shall devote the remainder of this paper to matters of direct clinical interest. The form of anesthesia herein described has now been in use in the surgical clinic of the Johns Hopkins Hospital for two years. Here over 2500 patients have been anesthetized by this method. It is now our routine form of anesthesia for all operations except those on the face, upper air passages, or cranium. In these we have found it inconvenient on account of the difficulty of keeping the mask in place.

Before operation the patient is given an enema and deprived of food for several hours, but is allowed to take small quantities of water. Thirty minutes before the anesthesia is begun he is given a hypodermic of morphine and atropin, the dose for an adult being: morphine, $\frac{1}{6}$ grain; atropin, $\frac{1}{100}$ grain. The anesthesia is started after the patient has been placed on the table and while the field of operation is being surrounded by sterile towels. It is established so quickly that the incision can usually be made in two minutes after the mask has been put on. Any depth of anesthesia, which the condition of the patient or the nature of the operation may require, can be easily obtained, because of the control of the patient's respiration which is given by the rebreathing. In abdominal operations, if the increased activity of the respiration is inconvenient, it can be prevented by giving a fresh supply of gas at frequent intervals. The bleeding during gas-oxygen or gas-ether anesthesia is about the same as during open ether anesthesia. The patient's temperature, provided he is kept dry and covered,

will be found elevated from 0.5° to 2° after an hour's operation. With light narcosis under nitrous oxide and oxygen alone, the pulse may be rapid—from 140 to 160 to the minute, but this is of no significance, provided it is regular and of good quality, and there is no hemorrhage. The rapid heart rate decreases when ether is given.

This form of anesthesia is especially well suited for long operations. In fact the anesthesia does the patient so little harm that within reasonable limits the duration of the narcosis need not be considered. The surgeon can, therefore, operate with a deliberation and attention to detail that would otherwise be unjustifiable. The following typical cases show the truth of this contention.

CASE I.—Surgical No. 25268. A negro man, aged twenty seven years, in good physical condition. Operation: Excision of a sarcoma from the right popliteal space, and bloodvessel transplantation. Duration of anesthesia, five hours. The pulse rate per minute varied from 72 to 100. The blood pressure at the end of four hours of anesthesia was 130 mms. of mercury. The patient regained consciousness before leaving the table. He had no headache, nausea, or vomiting, though he was given water at once. His urine after operation contained no albumin or acetone. He was allowed to rebreathe at two and one-half and three minute intervals. The narcosis was deep and quiet. Ether was given with the gas for the first half hour.

CASE II.—Surgical No. 27685. A white woman, aged thirty years, in rather poor condition. Operation: Resection of the ascending and transverse colon. Duration of anesthesia, two hours and five minutes. No ether was used. The narcosis was light, the patient at times moving her limbs. Recovery was immediate and unattended with headache or vomiting.

CASE III.—Surgical No. 27667. A colored woman, aged thirty years, in good condition. Operation: Excision of the right breast, pectoral muscles, and axillary glands for advanced cancer of the breast; Thiersch skin grafting of the raw surface of the breast. Duration of anesthesia, three hours and fifty-five

minutes, 2½ ounces of ether, 130 gallons of gas, and 30 of oxygen were used. The anesthesia was quiet and satisfactory, the recovery immediate and without headache, nausea, or vomiting.

I could report many more cases similar to the above, but these show sufficiently well how little the patient is injured by this form of anesthesia. A word of caution is, however, necessary. This is that during any administration, and especially during a long administration, the patient's breathing must be kept free and unobstructed, and his color good. If a patient has to work hard for every breath he soon wears himself out. The color of the blood in the wound, the hue of the patient's face and the character of his breathing as shown by the movements of the rubber bag, are the best indicators of his condition. The surgeon himself can hardly fail to notice these. If the patient's breathing cannot be kept unobstructed, the use of the apparatus should be abandoned at once, and some other method of anesthesia used.

We have had three fatalities, during or immediately after operation, in our series of 2500 cases. How much the anesthesia was to blame for these may be judged from the following reports.

Fatality No. 1. Surgical No. 25831. A colored woman, aged forty-four, with exophthalmic goitre of four year's standing. She had an irregular, intermittent pulse, the rate of which had been between 120 and 140. Her heart was enlarged, and she had ascites and edema of the ankles. During the last week of her life she had several severe attacks of dyspnea, associated with extreme rapidity and irregularity of the pulse. For these she was given a course of digitalis, which improved her condition so much that it was thought she could withstand a partial thyroidectomy. When the mask was placed over her face she made a very slight struggle, and took several shallow breaths. The operator then saw the superficial veins of her neck suddenly dilate. This apparently marked the time of death, and occurred within half a minute of the time the anesthetic was started.

Fatality No. 2. Surgical No. 25723. A man, aged 65 years, with aortic and mitral insufficiency, on whom it was proposed to do a perineal prostatectomy. He was given ether with the

gas and oxygen. The anesthesia went very well until the patient was placed on the perineal table with his buttocks elevated, then he became cyanotic and died. An immediate autopsy revealed the presence of a large pericardial effusion, the presence of which had not been recognized before operation.

Fatality No. 3. Surgical No. 26238. A girl, aged sixteen years, with multiple infectious arthritis; general condition poor. Operation: Injection of both knees with oil, and manipulation of knees, ankles, and elbows. Duration of anesthesia, fifteen minutes. The anesthesia was uneventful, except for a marked increase in pulse rate while each joint was being manipulated. At no time was the breathing obstructed. At the close the pulse rate went up very rapidly, and the color became very cyanotic and could not be cleared up with oxygen. Her breathing got weaker and weaker and finally ceased.

An autopsy showed a very large thymus and hypertrophy of all the lymphatic tissues. The pathologists gave status lymphaticus as the cause of death.

The first and second of these cases had circulatory disease of such gravity that the anesthesia is not to be seriously blamed for the deaths. How the third fatality was brought about I am at a loss to understand. The toxicity of nitrous oxide is certainly too low to have caused it.

Notwithstanding these fatalities, I believe that this form of anesthesia properly employed is well suited for cardiac cases. Two cases of Cesarean section, performed by Professor J. W. Williams on women with serious valvular lesions will show the grounds for this belief. Both women were in about the seventh month of pregnancy, and in both delivery was necessary to save the life of the patient. One of the two was *in extremis*, and her death on the table was regarded by the operator as probable. Both women has such urgent dyspnea that the anesthetic had to be started with the patient sitting upright. The same method of administration was employed in both cases. The patient was given a hypodermic of morphine large enough to quiet her. In inducing anesthesia great care was exercised to avoid the least

excitement or struggling on the part of the patient. Both were allowed to rebreathe oxygen until the respiration was stimulated before any nitrous oxide was given. Enough ether was used to give a quiet anesthesia. The operations were performed with the patients' bodies elevated at an angle of 20 to 30 degrees. The pulse of both patients was much better during anesthesia than before, and the operator was able to proceed without undue haste. Both cases made an excellent recovery.

I have hitherto spoken of the advantages of an excess of carbon dioxide in the blood—a hypercapnia—during anesthesia. Our clinical experience has certainly shown that this to the degree we permit is harmless. Hill and Flack state that "the effects of CO_2 on the heart can always be quickly recovered from, even if the blood pressure has sunk to zero." These authors found that carbon dioxide up to a percentage of 35 in the air breathed stimulates the respiration; while above 35 it depresses it; also that percentages up to 22 produce a rise in blood pressure, while higher percentages cause a fall. Of course, it is impracticable to determine exactly what per cent. of carbon dioxide a patient is breathing. The anesthetizer must regulate the time of rebreathing so that the patient's respiration is moderately stimulated. The periods of rebreathing for 10 liters of gas range for three to five minutes, any leakage from the apparatus being meanwhile made good by the addition of fresh gas.*

Does a deficiency of carbon dioxide in the blood, an acapnia, do serious harm? The work of Professor Henderson on this problem is so well known as to require no more than a reference here. He has been able to reduce animals to a state of extreme shock by overventilation of their lungs. He asserts that acapnia causes complex osmotic changes in the tissues, which result in a passage of water from the blood into the lymph and into the tissue cells and a dilatation of the finer veins. Interference

* After rebreathing 10 liters of oxygen for three minutes I found it to contain 8.9 per cent. CO_2. Allowing for decreased CO_2 formation during anesthesia, it is probable that the percentage breathed by the patient is seldom above this.

with the normal filling of the right side of the heart by this process is the essential phenomenon in surgical shock. In extreme cases of acapnia the blood stream is so scant and the respiration so feeble that the tissues do not receive the necessary amount of oxygen. An asphyxial acidosis results, which does the body cells irreparable injury. Whether we accept Henderson's theory or not we must admit that the accumulation of carbon dioxide by the process of rebreathing is an efficient stimulus to the respiration and circulation. In fact, we use it as a purely therapeutic measure in cases of morphine poisoning, in cases of so-called traumatic or toxemic shock,* and wherever the respiration is feeble.[19] Oxygen can be given much more effectually and cheaply by the use of rebreathing than in the ordinary way. Thus, with anesthetics of low toxicity and the use of rebreathing, we can sometimes actually benefit a very ill patient by an anesthesia.

On the other hand, when we give ether by the open method we take a very efficient means of producing acapnia, because ether diminishes the formation of carbon dioxide by the tissues, and by stimulating the respiration, hastens the elimination as well. Symptoms of a mild grade of acapnia under open ether anesthesia are common. Thus a patient who has perhaps been difficult to anesthetize, who has been lightly under ether for some time, and breathing at a rapid rate, will gradually stop breathing. After an interval of perhaps two or three minutes his respiration will start again, but will not be normal for a long time. This occurrence, though alarming, is usually followed by no harmful results. Of course, hundreds of patients are etherized daily by the open method without developing symptoms of shock. What prevents a serious grade of acapnia in the great majority of cases? There are a number of things which do so. In the first place many anesthesias are of too brief duration for acapnia to develop. Then again there is frequently more or less

* Patients with feeble pulse and respiration—so-called "shock" cases—should be made to rebreathe air or oxygen until their respiration is normal before starting the anesthesia.

obstruction to the breathing during narcosis, and this prevents acapnia. Likewise the slowing of the respiration which results from a preliminary hypodermic of morphine may protect from the same danger.[21] Finally the so-called "open" method is usually not "open" at all, for the mask is so covered with towels or gauze that the patient does considerable rebreathing.

It is a pity that in a case like the following accurate determination of the amount of CO_2 in the blood could not be made, so that we could judge whether or not death was due to acapnia:

The patient was a well-nourished, middle-aged woman, with no disease of the heart or bloodvessels, on whom a colostomy and an excision of the rectum was done for a carcinoma. The anesthesia was by the "drop ether" method, and was of two hours' duration and rather light. The patient's breathing was rapid and carefully kept free from obstruction. There was practically no loss of blood and but little trauma connected with the operation. The patient never regained complete consciousness, though she could respond feebly when spoken to. Her pulse was rapid and of poor quality; her temperature subnormal, her color slightly cyanotic, and her respiration very feeble. She never rallied, and died eight hours after operation. An autopsy showed no apparent reason for death, which was attributed to surgical shock.

Is it not possible in this case that an acapnia had produced fatal injuries to the tissues in the manner described by Henderson?

Apart from the prevention of acapnia, the form of anesthesia I have described has several other advantages over open ether anesthesia. The chief of these are three: (1) Lessened postanesthetic vomiting. (2) Decrease in number of cases of abdominal distention after operation. (3) Practical abolition of postanesthetic lung complications.[22]

Vomiting after operation, of course, depends on many things besides the anesthetic. About 35 per cent. of our cases vomit, but the vomiting is usually very little. In looking over the special charts of 200 patients, I found only four who had had

more than very transient vomiting. Of these one was a case of exophthalmic goitre, one a case of stone in the common bile duct, one a case of spreading peritonitis from an appendix abscess, and one a case of intestinal resection. The nausea alone seldom prevents a patient from taking water and nourishment at once after operation.

There has been very little experimental work on the question of abdominal distention following ether anesthesia. Cannon and Murphy[23] observed a great delay in the emptying of the stomach contents into the duodenum, and a slowing of the passage of food along the intestines after etherization.* It is well recog-

* I wish to thank Dr. Hooker for the following note:

Dr. Gatch has asked me to add a foot-note covering some unpublished experiments done in the Physiological Laboratory of the Johns Hopkins University which appear to have a direct bearing on his own work.

Cross-sections of bloodvessels or intestine to which a recording lever was attached were hung in a moist chamber. In the use of tissues from warm-blooded animals the temperature of the chamber was maintained constant at 35° C. Through the chamber was passed alternately streams of oxygen and carbon dioxide gas. By this method the tissue studied was exposed to practically pure atmospheres of the gases. The experimental conditions, therefore, did not fall within physiological limits so far as the percentage of gas is concerned. Work is now in progress to investigate the effect of different percentages of oxygen and carbon dioxide. Aside from the result of this future work, however, the interesting fact has been demonstrated that the musculature of the bloodvessels responds in atmospheres of the gases studied in an exactly opposite manner to the musculature of the intestines. Carbon dioxide causes a marked improvement in the tone of the intestines, and a marked relaxation of tone in the veins and arteries. On the other hand, oxygen causes a relaxation of tone in the intestines and an improvement of tone in the veins and arteries. These results were obtained in the case of both warm and cold-blooded animals, and demonstrated with graphic records.

If it be true that Henderson reasoned by analogy from the behavior of the smooth muscle in the gut to that in the bloodvessel (especially the veins) in developing his acapnia theory of surgical shock, it is obvious from these results that his reasoning was not entirely justifiable.

The correlation of the difference in action of these gases in physiological economy tempts speculation. The body seeks to be rid of any excess of carbon dioxide. Jerusalem and Starling (*Journal of Physiology*, 1910, xxxviii) have shown that carbon dioxide ($\frac{1}{8}$ per cent. of an atmosphere) increases the efficiency of the isolated mammalian heart chiefly by improving its diastolic relaxation. Bayliss (*Journal of Physiology*, 1901, xxxii, p. 32) and the writer have shown that this gas relaxes vascular tone. In the gut it has long been known that the same gas increases peristalsis, and Mall (*Johns*

nized that an excess of carbon dioxide in the blood promotes peristalsis, and Henderson[24] has shown that the normal intestinal movements, which cease after a laparotomy, can be restored by passing a stream of CO_2 over the exposed bowel. These experimental results are confirmed by our clinical experience. It will be recalled that we use the smallest possible amount of ether, and produce a hypercapnia by making the patient rebreathe. In the two hundred cases referred to above there was not a case of abdominal distention, except after laparotomy, and among the laparotomies, 75 in number, it occurred in but 3 cases, these being the same patients who had considerable vomiting.

In 2500 cases of gas-oxygen or gas-oxygen-ether anesthesias, we have had but one case of post-anesthetic pneumonia—this in a girl with general peritonitis, who recovered. I am perfectly aware that this absence of pneumonia has been partly accidental, since pneumonia after operation may be due to causes other than the anesthetic. The record is, however, striking, and all the more so because we have anesthetized without hesitation, cases of pulmonary tuberculosis, bronchitis, and empyema. It contrasts markedly with the record after open ether. Here is a series of 400 cases; we have had one death from ether pneumonia, and 2 deaths, one with autopsy, from acute pulmonary tuberculosis.[25] The latter cases were both operated upon for tuberculous glands of the neck. Both cases died rather late—in from two to three weeks after operation—but they ran a high temperature from the first. It was the opinion of Dr. L. V.

Hopkins Hospital Reports, 1896, i, 37) has suggested that rhythmical movements of the intestines may help to empty the venous plexuses in the walls and thus aid in driving the blood into the portal system. We have therefore a coördination of activity which greatly facilitates the circulation of blood and the consequent rapid elimination of the carbon dioxide. Oxygen in excess, on the contrary, would tend to bring about opposite effects with a resultant retardation of the circulation.

In conclusion it should be clear to the reader that this is a chemical regulation of the circulation entirely peripheral in its action. The action of the gases in the medullary centres is a wholly different question.

D. R. Hooker.

Hammond, who has charge of the work on tuberculosis at the Johns Hopkins Hospital, that the etherization had lighted up small apical foci of disease undetected before operation.

In closing I do not wish to leave the impression that this form of anesthesia is free from danger. It is without danger so far as post-operative effects are concerned. During the administration, however, there are dangers. These, however, can always be prevented by careful and skilful administration, and arise from causes which can generally be foreseen. The method should not be used except by those who have made a special study of its problems.

Summary.

1. Rebreathing, when properly regulated, and when the oxygen supply is ample, is harmless and can be put to a valuable use.

2. If we can prevent anoxemia, our concentration of vapor and too great a depth of anesthesia, we can obviate most of the serious objections to the closed method of giving ether.

3. The process of rebreathing prevents the elimination of ether and chloroform by way of the lungs, and overventilation of the lungs hastens the elimination.

4. It is suggested that after any administration of ether or chloroform overventilation of the lungs be brought about by the use of mixtures of oxygen and carbon dioxide.

5. Morphine, or any drug, which depresses the respiration retards the elimination of ether or chloroform.

6. A method of administering nitrous oxide, and if necessary, ether, with oxygen, by the method of rebreathing is described and its advantages and dangers discussed.

Its chief advantages are:

1. The rapidity and pleasantness with which anesthesia is established.

2. The ease with which any depth of anesthesia can be secured.

3. The prevention, to a very large extent, of post-anesthetic vomiting, pulmonary complications, and abdominal distention.

Its chief dangers are:

1. Anoxemia, due to failure to give sufficient oxygen, or to an obstructed air way.

2. Impediments to the respiration, which in a long anesthesia may exhaust the patient.

3. With cardiac cases, excitement during the period of induction.

REPORT OF MISS STELLA S. MATTHEWS, ANESTHETIST FOR DR. J. L. YATES, OF MILWAUKEE.

Number of N_2O–O anesthesias	122
N_2O–O	89
N_2O–O and ether	33

Post-operative vomiting, 30 per cent.

In two cases the vomiting was prolonged, in both vomiting due to other conditions than anesthesia, in most cases it was very slight and not more than once or twice. Several times it was before leaving the operating room, not any thereafter. As more care is being taken in the preparation there is less vomiting. The percentage of vomiting was larger when ether had been given with the N_2O–O, 39 per cent.; without ether, 27 per cent.

In most cases a preparatory dose of morphine and hyoscine (grain $\frac{1}{4}$ and $\frac{1}{100}$ respectively as routine) was given one-half hour before the anesthetic.

We think much of the vomiting was due to that, but not enough to contra-indicate its administration, as upon this, we believe, depends the success of the method.

With most cases of vomiting there was headache, frequently with dizziness.

Headache without vomiting about 3 per cent.

Character of anesthesia was generally very good. A few anesthetics have been given for outside men. These have frequently been the hard ones, as there was not sufficient relaxation before the operation was commenced.

With careful preparation hemorrhoid operations can be done without ether. We have had three such operations where it was not necessary to give any ether, but the patient was put in position before the anesthetic was begun.

For all perineal operations we have found this a very important procedure.

Have not experimented with the rebreathing, doing it generally for about four minutes.

There have been no pulmonary complications.

The subjects have varied in age from a baby of seven months to a woman aged seventy-seven years and one man aged eight-six years.

The following are a few of the most interesting cases.

Several with complete breast operations, one of these within sixteen days had eight hours and twenty-five minutes of anesthesia with not the slightest sense of discomfort from the anesthetic. One taking the anesthetic for three and one-half hours talked much of the time, remembered hearing voices, but had no sense of pain.

Several have taken the N_2O–O for a mastoid operation; one of these was a woman five months pregnant, and she had not the least discomfort from the anesthetic.

One case of appendicitis with pulmonary tuberculosis was very hard to keep from becoming cyanotic, pulse was regular throughout operation and there was no nausea, vomiting, or headache after.

One patient with tuberculous glands of neck in a little over a month had ten hours' anesthesia at five different times. One was given with ether through tubes and there was much vomiting after. The other four were with N_2O–O, no vomiting following.

One case of laminectomy, with mask tied on to keep from slipping, took the anesthetic for three hours and fifteen minutes. The position was very awkward, and the patient in poor condition. At one time the pulse became very irregular and of poor quality, but as soon as operation was finished and anesthetic stopped, the patient was apparently in as good condition as at the beginning.

One patient with brain abscess took the anesthetic for four hours and twenty minutes. Pulse to begin with was 48, went up to 80, and remained between 60 and 80 during operation.

One or two patients who have been accustomed to take more than their allowance of alcohol have been very hard to get thoroughly relaxed without resorting to considerable ether, but only once have I had to give up the N_2O–O and use ether entirely.

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INTRATRACHEAL INSUFFLATION.

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The essentials of the method of intratracheal insufflation consist (1) in the introduction deep into the trachea of a flexible elastic tube, the diameter of which has to be much smaller than the lumen of the trachea, and (2) the driving through this tube of a nearly continuous stream of air which returns through the space between the tube and the walls of the trachea. The distinguishing features of this method consist in the following two new principles: (1) By bringing the pure air directly to the larger bronchi, and by driving out the vitiated air from these bronchi through the force of the returning air stream, that part of the "death space" is eliminated which is represented by the mouth, pharynx, larynx, and trachea. The chief aim of the complicated nervous and muscular mechanisms of respiration is to establish an efficient ventilation, capable of overcoming the obstacles offered by the mentioned "death space." A well-arranged intratracheal insufflation is fully capable of relieving and substituting the normal respiratory mechanism. (2) The practically continuous recurrent air stream prevents the invasion of indifferent or infectious foreign matter from the pharnyx into the trachea.

The usefulness of the method is at least threefold: (1) It is capable, as stated before, of keeping up an efficient respiration in cases in which the normal mechanism of the external respiration fails. (2) It overcomes efficiently and conveniently the

difficulties presented by double pneumothorax. (3) It offers a safe and reliable method for anesthesia, especially for the administration of ether.

In the course of the last two years, since the first publication by Dr. Auer and myself on "Continuous Respiration without Respiratory Movements,"[1] several hundred experiments were carried out in our department at the Rockefeller Institute on the various phases and relations of the method of intratracheal insufflation. In the very short time at my disposal, I shall confine myself to brief reports and considerations of the more practical results of several series of investigations.

The Innocuousness of the Method. We shall deal first with the question whether any injury can be done to the respiratory organs by the use of intratracheal insufflation, as was urged, on purely theoretical grounds, by critics of this method. We devoted a good deal of attention to this point. The following results give, I believe, an unmistakable answer. (1) The method was practised in a very large number of experiments, in most of them the insufflation lasted for many hours, and in some as long as twelve hours. In not a single case did bronchitis or pneumonia develop which had to be ascribed to the preceding insufflation. Pulmonary affections are not a rare occurrence in dogs, expecially in stray animals. Nevertheless, the dogs which were subject to insufflation did not show a greater disposition toward respiratory affections than animals which were not exposed to such treatment. (2) In two systematic series of experiments carried out by Dr. Githens and myself, the question of aspiration was studied by means of severe tests. In one series after filling up the stomach with acid solutions, vomiting was produced by hypodermic injections of apomorphine. The vomited material was left in the mouth and pharynx for a long period during the insufflation. In another series mouth and pharynx were filled with a suspension of powdered charcoal. The animals were kept during this period under deep or light ether anesthesia. In not a single case in which insufflation was practised was vomited matter

[1] Jour. of Exper. Med., 1909, xi, 622.

or some of the charcoal found in the trachea or bronchi. On the other hand, when a tube was in the trachea, but no air was driven through the intratracheal tube and the condition therefore was, to a degree, similar to Kuhn's method of peroral intubation, the contents of the mouth and pharynx often came out through the free end of the tube. Furthermore, when deep anesthesia was induced, in these latter experiments, especially in the experiments with charcoal, the animals died in a few minutes, and at the autopsy trachea and bronchi were found to be loaded with charcoal. When the animal was only lightly anesthetized, so that the deglutition reflex remained active, rapid swallowing seemed to clear away most of the foreign material present in the pharynx. These parallel experiments demonstrate with great distinctness the efficiency and importance of the recurrent air-stream in the insufflation method. (3) In an investigation carried out by Dr. Lamar and myself we succeeded, in a large number of experiments upon dogs, to produce lobar pneumonia in every instance, with a mortality of over 15 per cent. Employing now the same method, Dr. Githens and I produced lobar pneumonia in a series of nine dogs and subsequently practised insufflation upon them for one hour every day for eight to ten days. Not a single animal of this series succumbed to pneumonia. These latter experiments certainly show that insufflation brings no greater danger to the respiratory organs even when the animals are already afflicted with such a serious but not intensely fatal disease as lobar pneumonia.

All our various extensive experiences, therefore, demonstrate conclusively that the method of intratracheal insufflation, far from being a menace to the respiratory organs, is rather capable of protecting them against injurious invasions of foreign matter.

Insufflation, Differential Pressure, and the Factors of Safety. Significant is the following consideration of intratracheal insufflation as a method to overcome the dangers of pneumothorax. Some surgical writers see in the intratracheal insufflation nothing more than a modification of the Brauer or the overpressure method; neither do they anticipate that it is

capable of accomplishing more than that method. This view is based upon an unfamiliarity with the essential principles of either of the methods and is entirely erroneous. The methods of overpressure as well as that of underpressure aim only at keeping the lungs distended, but do not provide for any ventilation of the lungs. This is left, as in the normal animals, entirely to the activity of the respiratory muscles. It is fundamentally different, however, with the method of intratracheal insufflation; if it is properly adjusted, it is able to carry on the process of ventilation with complete efficiency, without any aid of the respiratory mechanism. This difference is a vital point, which, however, is imperfectly understood by the workers in this line. Our own attention was directed to the importance of this difference by some striking results obtained by Dr. Auer and myself in a series of experiments in which the Brauer method and the method of intratracheal insufflation were compared. In these experiments after both pleural cavities were kept widely open for one hour or an hour and a half, both lower lobes of the lungs were removed from their approximation to the diaphragm and the posterior walls. When using the Brauer method the animals died in a short time, sometimes in two or three minutes. Furthermore, the replacing of the lobes and even the starting of proper artificial respiration could not in many if not in most cases restore the activity of the heart. In the insufflation method, on the other hand, even a fairly complete lifting out of the lungs from the thoracic cavity never interferes with the activity of the heart. A further difference in the behavior of the heart could be observed, when the pressure keeping up the inflation or the insufflation was discontinued and the lungs permitted to collapse. In the Brauer method already a few seconds after the discontinuation, the heart becomes slow and is liable to stop in less than half a minute; while under the insufflation method a minute and a half and even two minutes may pass before the effects of asphyxia will show themselves. The same difference is manifest in the readiness with which the heart recuperates after the pressure is restored again. What is the

cause of this difference? To my mind the difference consists in the unquestionable fact that in *the Brauer method the respiratory process is frequently deprived of nearly all of its factors of safety, while in the method of the intratracheal insufflation none is missing*. The question of the preservation of the factors of safety is such an important requirement in many fields of surgical activity that I shall try to explain its meaning a little more fully.

A few years ago, in a Harvey lecture, I have shown that the various mechanisms of the animal body are, like human-made machines, well provided with factors of safety. When a bridge, a building, or a machine is constructed, it is built, in the first place, to be able to resist the *expected maximum of stress* or to accomplish the *expected maximum of work*. Besides this provision, still further powers of resistance are added to the structure, or dynamic efficiency is added to the machine, in order *to meet unexpected exigencies*. These additions are termed factors of safety. They may consist of fourfold units or of tenfold, twenty-fold, etc., according to the necessities of the object for which the structures of the machine are built. In the animal body we find that the kidneys have functional substance more than twice, the liver four times, the thyroids six times, the pancreas at least ten times more than is absolutely necessary. To come to the point under discussion, the normal respiratory mechanism provides for an exchange of gases to a much greater extent than is absolutely indispensable for the maintenance of life—it is provided, as we say, with a large number of factors of safety. How large they are, we may get an idea when we analyze the conditions prevailing in the Sauerbruch or in the Brauer methods.

As stated before, in both methods the actual respiration is accomplished by the contraction of the respiratory muscles. By the inspiratory distention of the thoracic cavity, and the decrease of pressure therein, air is made to rush into it, to make up the deficit. In normal animals the air can rush in only through the trachea alone; in animals with open thorax, however, air may rush in also through the opening in the wall of the thorax. The same is true also of the expiration, the movements of the

air being only in the reverse direction. Now since the opening in the thoracic wall during an intrathoracic operation is by far much larger than the lumen of the trachea or that of the glottis, it is evident that only a very small fraction of the air enters and leaves the tracheal path, during inspiration and expiration. That fraction of a respiration is surely too small to maintain life even for a short time. However, we may assume that even under these circumstances air rushes through the trachea into the lowest and most posterior part of the lungs, by the virtue of their close approximation to the respiratory muscles, more readily than through the artificial opening in the thoracic walls. These parts of the lungs, when in normal position, contribute therefore essentially to the maintenance of life under these precarious circumstances; hence the fatal effects of the separation of the posterior lobes from their natural approximation.

But, whatever the mechanism may be, it is evident that the total sum of the various contributions to the exchange of air in the methods of differential pressures can be only a small fraction of the exchange which takes place in normal conditions. Nevertheless this fraction is frequently sufficient to keep up the life of the animal for a long time, to keep it up during an operation which may last for several hours. This shows that the exchange of gases in the normal external respiration is many times more extensive than is necessary for the immediate maintenance of life; in other words, the normal function of the external respiration is provided with many factors of safety. But it shows also that under differential pressure the external respiration is frequently deprived of most of its factors of safety. What is said of the external respiration applies also to the internal respiration, and we may therefore say that in operations under the Sauerbruch or the Brauer methods the nerve cells of the medulla and the muscle fibers of the heart continue to functionate under a minimum exchange of gases. But we must remember that these structures are very sensitive tissues. Normally their activity is protected against any mishap by a great many factors of safety, by an abundance of gaseous exchange. When

they persist on a minimum, they are continually on the danger line; the slightest mishap may affect the minimum, and the life of these sensitive structures is extinguished, and what is worse, a subsequent abundant supply of internal respiration frequently fails to resuscitate them; artificial respiration fails to resuscitate the animal which was exposed for a long time to the dangers of a minimum respiration. And here is the general significance of the preservation of the factors of safety during a surgical procedure. Life may seem to continue satisfactorily without the factors of safety as well as with them. But when persisting only on a minimum, life is continually on the border-line of danger; any small accident may destroy it beyond recall. With an abundance of factors of safety small incidents leave no impression, and when a stronger mishap occurs, proper means, early applied, bring recovery—the controlling sensitive tissues are still in a recoverable state. This applies to many surgical conditions. In intrathoracic surgery, under differential pressure, external and internal respiratory processes are deprived of most of their factors of safety, the life of the medulla and of the heart persists throughout the operation on a minimum of the gaseous metabolism. If the operation is terminated without an incident the individual may recover without manifesting any sign that it ever was in danger. If, however, some mishap occurs, and be it ever so small, that minimum of internal respiration may become extinguished and life be gone beyond recovery. When this occurs, and it has occurred, surgeons ascribe the fatal result to a vagus effect, a reflex shock and what not else. But the mishap, whatever it may have been, was only the accidental terminal cause; the real cause of the fatal result is to be found in the fact that the life of the patient, under differential pressure, persisted too long on a minimum supply of internal respiration, and medulla and heart lost all their power of resistance. The addition of appliances for artificial respiration to differential chambers will frequently fail to mend the evil. Artificial external respiration, and be it ever so efficient, often will not restore the life of the sensitive nerve cells and the heart muscle fibers which,

after being exposed for a long time to a mere minimum of internal respiration, lost all their recuperating power.

Summing up in a few words: Under even the best arranged differential pressure methods, the life of patients with a double pneumothorax persists on a greatly reduced supply of external and internal respiration, and is continually exposed to the dangers which may result from it; under properly arranged intratracheal insufflation, however, the patient is supplied with an abundance of external and internal respiration, and is at no time in danger from this source.

Anesthesia by Intratracheal Insufflation. In my first paper[1] on the method of intratracheal insufflation about fifteen months ago, my statement with regard to anesthesia reads as follows: "On the basis of my observations and experiments it seems to me that the giving of ether by the method of intratracheal insufflation is the safest and the most effective way of administration of this anesthetic." Since making this statement we had considerable experience with the administration of ether by the insufflation method. We used and use it daily, and for all kinds of experimental operations; it is the routine method of anesthesia in our laboratory. And I am willing to state now, and even with greater emphasis than before, that it is the ideal method of administration of ether anesthesia. If properly adjusted and supervised, the anesthesia may last for many hours, without the occurrence of serious incidents during the anesthesia or of serious consequences subsequent to it. Eight dogs were kept for twelve hours continuously under profound anesthesia; there were no disturbing incidents during the anesthesia and none subsequent to it. Even in these prolonged anesthesias the animal recovered from them in less than half an hour. In the numerous experiments of Shaklee, and of Githens on the treatment of strychnine poisoning by insufflation, the animals were kept continuously under profound anesthesia for many hours, sometimes as long as eight.

The anesthesia by the insufflation method is far superior in

[1] Meltzer, Medical Record, 1910, lxxvii, 477.

many respects to that of the usual method of administration of ether. It is much safer, the anesthesia is much more readily controlled; the animal gets under it more quickly when the ether is turned on and gets more quickly out of the anesthesia when the ether is turned off; it requires only scant supervision, and not much ether is used up. The method offers also the great safety that efficient artificial respiration may be immediately instituted at the first appearance of dangerous or even only of doubtful symptoms, and this merely by turning of a screw clamp or a stopcock. The effects of anesthesia disappear very rapidly and especially so, when after interruption of the anesthesia, pure air is insufflated for a few minutes before the removal of the tube.

Of the various studies which we carried on regarding the relation of the insufflation anesthesia to blood pressure, respiration, etc., I shall mention here very briefly only a few facts. In the first place I wish to make a correction. In my first paper I stated that I did not succeed in killing dogs with ether, when administered by the insufflation method. In recent studies of Dr. Githens and myself on the influence of the anesthesia upon blood pressure and respiration, we found that under certain conditions ether might become fatal even when administered by insufflation. These studies brought to light instructive results. When an animal is brought under the influence of anesthesia under conditions which are just sufficient to make the anesthesia complete, for instance under an insufflation pressure of 30 or 40 mm. of mercury, and with an air stream going three-fourths through a bottle containing ether and one-fourth as pure air, the animal will remain in the same excellent state of blood pressure, respiration, etc., as long as the external conditions remain the same. However, if the conditions change, for instance, if the entire air stream passes through the ether bottle, we may see now the blood pressure starting to go down, its various undulations gradually disappearing, and the respiration becoming more and more shallow and slow, until it completely ceases. Even then the heart continues to beat regularly and effectively, although the pulse pressure is usually somewhat decreased. If

this state is permitted to continue for an hour or longer, the animal cannot be saved any more. However, if twenty or thirty minutes after the spontaneous respiration ceases the former conditions are restored, or still better, the insufflation of entirely pure air is instituted, the blood pressure begins to rise and the respiration begins to make its appearance, until in a comparatively short time normal and safe conditions prevail again. In these experiments a strong overdose of ether paralyzes first the functions of the medulla and much later that of the heart. Of course, these were severe experimental tests and cannot and should not occur in human surgery. Here it should be the rule to reduce the ether as soon as the respiration becomes shallow and slow. Of the further remarks which I wish to make and which of necessity will have to be extremely brief and aphoristic, I shall mention in the first place the important fact that if the intratracheal tube is only of moderate size, the insufflation pressure can be increased considerably without causing any injury whatsoever. Under these conditions an increase of 30 mm. of mercury in the external pressure may mean an increase of only 1 mm. within the bronchi. The increase of pressure will often prove beneficial when the patient shows some cyanosis; the tube might in this case be too small. The increase of pressure might prove useful also in facilitating the anesthesia in very resistant individuals. Such an individual resistance to ether occurs also among animals, but not with that frequency and to that degree as it may be met with in human beings with their goodly number of neurotics and alcoholics. The higher external pressure is the means of driving into the bronchi a larger quantity of ether (and air) in a unit of time. A similar result may be obtained by frequently exerting a slight pressure upon the larynx for a second or two; this brings a greater distention of the lung with all the advantages which are to be derived from it. I may mention here also the facts that the anesthesia is more rapid and more effective, the larger the bottle is which contains the ether and the more ether it contains.

Our studies of chloroform are, so far, not so extensive as

those of ether, but we know already a few things about it which ought to be mentioned here. Prolonged anesthesia by chloroform led sometimes to hyperemia and even to inflammation of the lungs. Furthermore, chloroform anesthesia requires careful supervision; it affects readily the functions of the medulla. However, with proper supervision chloroform may be used for shorter operations with perfect confidence, and it may be readily employed especially in individuals resistant to ether, at least for the purpose of the induction of the anesthesia.

In using insufflation in human surgery, whether for the purpose of anesthesia or for intrathoracic operations, it ought to be the rule that the continuous air stream should be interrupted five or six times per minute for one or two seconds at a time. From extensive experience we know that these short interruptions, which do not admit any aspiration, constitute a very valuable factor, a factor of safety, in making insufflation safe and efficient. The interruptions help also in recognizing the degree of the distention of the thorax. If the distention is too strong, it is due either to too high an external insufflation pressure, which is easily remedied, or the tube is too large. In the latter case, no time should be lost in exchanging the tube for a smaller one. Too little distention is due to the comparative smallness of the tube. In this case, it is not always necessary to exchange the tube for a larger one. Increase in insufflation pressure, which should be done not too abruptly, will frequently remedy the deficiency. In addition, a momentary pressure upon the trachea, frequently exercised, does excellent service. The pressure, however, is best applied to the larynx, where a slight pressure causes a sufficient distention of the lungs.

It seems that in human surgery catheters are being used for intratracheal intubation, that is, the opening at the distal end is at the side of the tube and not at its end. I advise the employment of tubes which have one opening at the end and only there. By this means the insufflation may carry air as well as ether deeper into the bronchi, which obviously facilitates ventilation as well as anesthesia. The tube must possess a certain

degree of rigidity and elasticity. However, care must be exercised in the introduction of the tube. By the use of undue force an abrasion of the mucous membranes of the larynx or trachea might occur, which could lead to a serious emphysema. For human beings the best method of introduction is apparently the one which is now being used by Dr. Elsberg, that is under the guidance of a Jackson direct laryngoscope. I shall not dwell upon the methods for providing a continuous air stream and for regulating the anesthesia; they are simple mechanical problems which will be solved variously according to the bent of mind of the various surgeons. The simplest method is the one which I suggested some time ago and which consists of foot bellows for the generation of pressure, and of a Woulfe's bottle, branching rubber tubings, and screw clamps for regulating the anesthesia. In our laboratory we employ a respiration apparatus, which provides pressure for insufflation for several animals at the same time. For human surgery, Elsberg's compact apparatus is surely the best; it was developed with ingenuity and foresight, and it works with simplicity and perfection.

I shall add yet the remark that under exceptional circumstances air enters through the esophagus into the stomach. Under these circumstances a stomach tube, which is easily introduced and which does not interfere in the slightest with the insufflation, remedies promptly this insignificant complication.

Finally, I may be permitted to quote here from reports upon the use of insufflation anesthesia in human beings, kindly furnished me by Dr. Charles A. Elsberg, of the Mount Sinai Hospital, of New York, and Dr. Charles H. Peck, of the Roosevelt Hospital of New York. Dr. Elsberg, who was the first man to introduce intratracheal insufflation into human surgery, and who worked on that problem with ingenuity, scientific enthusiasm, and perseverence, used this method in over 125 cases; of these 10 were thoracotomies. There were no pulmonary, bronchial, or laryngeal complications. Postoperative vomiting occurred only in 4 cases. In 3 cases there was some abdominal rigidity. "All the patients awoke very quickly from the anesthesia and

were remarkably comfortable afterward." Dr. Peck, who is surely an unbiassed observer, began to employ insufflation anesthesia, by means of Elsberg's apparatus, about April 21, and reports now (June 7) on 32 cases. In 28 cases, he writes: "The anesthesia was ideal, the color was perfect throughout, and the respiratory movements quiet and regular. In four alcoholic males there was some difficulty in keeping the patient quiet and relaxed, not enough, however, to seriously interfere with the operation in any case. The recovery from the anesthesia has been very quick and quiet, with less stupor and discomfort than usual. None of the cases had postoperative hoarseness, bronchitis, or pneumonia, or any other postoperative complication which could be attributed to the anesthesia. I have been much struck by the absence of either shock or depression, especially in the old and the feeble patients." The oldest patient was aged seventy-four years and the youngest ten years. Some of the operations lasted three hours. One case of perforated duodenal ulcer with peritonitis "vomited profusely during the operation without interfering with the anesthesia in the least or aspiring any of the vomitus." Twenty-three of the patients had no postoperative vomiting, 4 vomited once very little, 3 vomited a few times, and 2 had more prolonged and persistent vomiting, 1 being a three-hour operation upon the glands of the neck, and one a case of intestinal obstruction with profuse vomiting, both before and after the operation. Both Elsberg and Peck say that in operations upon mouth, pharynx, superior maxilla, etc., "the method was ideal in preventing aspiration of blood and mucus, and securing perfect quiet anesthesia without difficulty." Both point out the value in many cases of having the anesthetist out of the operator's way, and "that it is much easier to guard against contamination of the operative field." Dr. Peck sums up by saying: "I have seen no ill effects of any kind from the method, and while my experience is still limited, I am convinced that it has many advantages in a variety of conditions, in addition to its special use for thoracic operations."

FATALITIES, SIMULATING STATUS LYMPHATICUS, INDUCED IN NORMAL SUBJECTS BY INTERMITTENT ETHER ANESTHESIA.

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The majority of all deaths under anesthesia fall into one or the other of two general classes—those of primary respiratory failure, and those in which sudden cardiac standstill is the critical feature. The attitude of surgeons toward these two forms of death presents a peculiar contrast. They blame the first on the anesthetist, the second on the patient. They impute to a patient succumbing to cardiac death one or another of three defects—hypersusceptibility to anesthetics, or heart disease, or status lymphaticus.

The principal point which I wish to urge in this paper is that in the large majority of fatalities of the cardiac type these three expressions are mere excuses. The patient is killed by the method of anesthesia no less than in a death of the respiratory type. The observations upon which I shall briefly report have led me to believe that in all probability a majority, or at least a large percentage, of all healthy human beings with no hypersusceptibility deserving the name, no cardiac weakness, and no status lymphaticus could be killed by the kind of treatment which usually precedes a fatality of the cardiac type. Most of what I shall have to say will be directed to showing what the essential features of this treatment are, and how they produce their fatal results. I wish to fix attention on this point: It is not what the anesthetist does to the patient at the time of death, or five

minutes before, which kills him. The patient may suddenly expire without the anesthetist having done anything improper for five or ten minutes before. If death occurs at eleven o'clock, it is the treatment which the patient received at 10.30 or 10 which really causes the fatality. It is especially light, incomplete, and intermittent etherization at the beginning of anesthesia which induces in even a perfectly healthy subject that proneness to sudden death which may manifest itself a half or three-quarters of an hour later.

I shall first discuss the relatively simple problem of respiratory death as expressed in terms of modern physiology, and shall then take up the more complex question of cardiac fatalities under anesthesia.

Progress in physiology during the last few years has established beyond all question the fact that the normal stimulus to the respiratory centre is the carbon dioxide in the blood. It is this influence, and not an adjustment to oxygen needs, which keeps us breathing. Anyone can do the crucial experiment demonstrating this at any time. Force yourself to breathe much more deeply and a little more rapidly than usual for a few seconds or minutes; and when you cease forcing your respiration you will for a time stop breathing altogether, or else breathe only occasionally or in a very shallow manner. The explanation is quite simple. You have diminished the store of carbon dioxide in your blood and tissues, and especially in the respiratory centre; and the centre accordingly remains quiescent until the carbon dioxide reaccumulates up to the stimulating strength. If you have persisted in the forced breathing for several minutes, the subsequent apnea may last until the oxygen lack becomes acute, and you turn blue in the face. The condition of diminished carbon dioxide is called acapnia, from the Greek word kapnos, or smoke. Literally acapnia means smokelessness.

In normal life the sensitiveness of the respiratory centre varies extremely little; and the automatic rate and depth of breathing maintain the carbon dioxide content of the blood extraordinarily constant. On the contrary, under various forms and degrees of

anesthesia wide variations occur—variations from 50 per cent. below to 50 per cent. above normal. By analyses of the gases of the blood of 45 dogs, I have shown that anesthetics alter the sensitiveness of the respiratory centre to an extraordinary degree. During light ether anesthesia, in the so-called stage of excitement, and especially when the administration is intermittent and the subject comes part way out of anesthesia, the sensitiveness of the centre is greatly increased. The subject, therefore, breathes excessively. A condition of acapnia is thus developed far more intense than a man can induce in himself by voluntarily forced breathing. In the same way a subject who is scared and excited before anesthesia breathes excessively. Acute pain likewise produces hyperpnea, and results in acapnia. On the other hand, full anesthesia restores the respiratory centre to a nearly normal sensitiveness; and deep anesthesia renders the centre much less sensitive than normal.

It is easy to see that any subject, human or animal, will stop breathing when the degree of anesthesia is such that the centre is insensitive to the amount of carbon dioxide present at that time in the blood. If the subject has been rendered acutely acapnic by the excessive respiration of intense pain, hysterical emotion, or by ether excitement, he is liable to stop breathing if he is later brought into even a very moderate depth of anesthesia. In a series of experiments in which I have intentionally reproduced the conditions of unskilful anesthesia by maintaining ether excitement for fifteen or twenty minutes, the subjects (dogs) came into such a condition of acapnia that respiration sometimes failed, and failed fatally, when the animal was so lightly anesthetized as to wink its eyes. In the laboratory, just as in the operating room, the heart in such cases usually continues for a time to beat with undiminished force. If artificial respiration is administered soon enough, spontaneous breathing can usually be restored and death prevented.

So much for the respiratory type of fatality, and the conditions inducing it. I turn now to the cardiac type of death, a problem at first sight much more enigmatic, but none the less explicable

on the basis of modern physiology and of experiments accurately reproducing the clinical conditions under which such fatalities occur.

In another series of intentionally unskilful anesthesias on dogs, I first induced a considerable degree of acapnia either by allowing the subject to fight during ether excitement or by the hyperpnea of pain. A little chloroform was then administered. In such cases it frequently happened that the heart suddenly failed, either simultaneously with respiration or even before the breathing afforded any sign of impending danger. The subjects were wholly irrecoverable by any procedure short of massage of the heart. As you are aware, physiologists were for a long time inclined to deny the occurrence of primary heart failure under chloroform. They have finally come to admit that the clinical observers were right. My experiments show not only that primary heart failure is a reality, but that it is quite easily induced. It is only necessary that the experimental conditions should be an accurate reproduction of those under which such deaths occur clinically. In order to illustrate the accuracy of my reproductions I will quote in abbreviated form a case reported within the last four or five weeks by a distinguished member of this Association: Male, fifty-five years old, moderate user of alcohol; vigorous normal heart and sound lungs. Operation for hydrocele. Ether was administered, but difficulty was experienced. After an unusual amount had been given without the desired result, chloroform was substituted with apparently satisfactory results. The operation was scarcely begun, however, when the patient was observed to be intensely cyanosed. In a moment he was pulseless, and soon after respiration ceased. This particular case recovered, but only by the desperate remedy of opening the abdomen and massaging the heart through the diaphragm.

Here was a case of the type which is usually referred to as "hypersusceptibility to chloroform." In my judgment such a conception is wide of the mark. That man had no special susceptibility to chloroform up to the time when the first whiff

of ether was administered. His hypersusceptibility was developed entirely by the prolonged period of ether excitement and excessive breathing to which he had been subjected. The resultant acapnia rendered his heart liable to sudden failure under an amount of chloroform which would have been borne with impunity if he had not been acapnic. Ample experimental evidence has been accumulated during the last four or five years to show that acapnia exerts deleterious effects upon the heart, and upon many other functions, no less than upon respiration.

My observations on this point may be summarized thus: Dogs which have not been excited at any stage usually take chloroform well. If you give too much chloroform, respiration usually stops some time before the heart. If, on the contrary, the subject has first been rendered acapnic, the hypersusceptibility thus produced renders even the strongest animals liable to sudden primary cardiac failure under an otherwise moderate dosage of chloroform.

Evidence of a very similar sort regarding cats has recently been reported by A. G. Levy[1] from the laboratory of Prof. Cushny, in London. If one administers chloroform to a cat without allowing the animal to become in the least degree excited, and gradually pushes the anesthetic to the point of death, respiration nearly always fails first. Levy, however, has observed sudden cardiac death. He has published very striking graphic records of the phenomenon. He especially emphasizes the point that this form of death does not occur in deeply chloroformed animals. It occurs only when the anesthesia is and has been light. His graphic records show a very active respiration prior to and right up to the instant of death, with normal arterial pressure and pulse, terminating with absolute abruptness in a cessation of heart beat and a precipitous fall of arterial pressure to the base line.

I turn now to the subject of primary cardiac death *under ether*. Because of the fact that ether is ordinarily very slightly,

[1] Jour. of Physiol., 1911, xlii; Proc. Physiol. Soc., p. iii.

if at all, toxic for the heart, such deaths are peculiarly enigmatic. Accordingly surgeons have been driven to invoke "unsuspected heart disease" or else a condition of "status lymphaticus" as the explanation. Now, I happen to have seen such deaths by the dozen, in cats under student anesthetization. Other physiologists and pharmacologists must have observed the phenomena, unless their students are naturally far more skilful anesthetists than are mine. So far as I am aware, however, this is the first occasion on which anyone has stated explicitly that primary cardiac failure can be induced, and induced easily and with certainty, simply with ether. Failure to recognize this in the past has been due mainly to the fact that dogs have hitherto been the principal experimental animals, and dogs rarely exhibit the phenomenon. Cats, on the other hand, and, as I shall try to show, many human subjects, after being rendered acapnic, are liable to die of primary cardiac failure under ether. They are hypersusceptible to ether in the same manner that acapnic dogs are hypersusceptible to chloroform.

The sequence of events causing such deaths will be clearer if I describe how they occur in my laboratory. The problem involves the psychology of the anesthetist. Often the student anesthetist is one who for a while has done very well. His first three or four cases have gone through the operation and experiment without a hitch. He gets a little careless, loses an animal, and is rebuked. With the next case his confidence is weakened. He is constantly afraid the subject is going to die. He is prone to take the cat out of the little tin box, in which we initiate anesthesia, before it is fully under. Thereafter he gives the ether with such caution that the animal may come out sufficiently to struggle and cry. It may have to be held while being brought under again. Fifteen or twenty minutes later, at a time when everything appears to be going smoothly, the cat's heart suddenly stops beating. The anesthetist is quite sure that it was no fault of his own, but that he must be extra careful next time. Then, if he happens to be a high-strung and nervous fellow, he is almost certain to give too little ether and thus to kill in four out of his

next five feline anesthesias. It is noteworthy that it is especially the wild cats, those which struggle and fight against anesthesia, which are peculiarly liable to die thus suddenly. I know of a hospital operating room in which at one time the very best quality of ether seemed to have lost a large part of its potency, and to have developed an exciting quality with bad after-effects. I suspect that in reality the trouble was psychological rather than chemical, and that the anesthetist simply needed sleep and rest, or, better, a week in the country.

Comparison of such laboratory observations with the reports which appear in the clinical journals seems to me to show with a high degree of probability that in a large percentage of the patients succumbing to primary cardiac failure under ether there has been no real heart disease and no status lymphaticus, but that an acute susceptibility equivalent to these conditions has been developed by unskilful anesthesia. Such cases are rare in large and well-appointed hospitals where hundreds of patients are handled by expert anesthetists, but relatively frequent in rural practice and in small hospitals where anesthetists are unskilled and anesthesias a rarity. A fatality of this class seldom occurs during profound and prolonged anesthesia. It is especially the sequel of light anesthesia.

Usually the printed accounts of such cases state expressly that the administration of ether was interrupted once, or twice, or several times, thus allowing the subject to come nearly out of anesthesia. The patient may even have winked his eyes only a few seconds before the circulation suddenly failed. He may have drawn deep gasping breaths some time after the heart had completely stopped beating. Quite often the case is that of a child under operation for adenoids. The writer of the report assumes that status lymphaticus was the cause of death, although there may have been no autopsy. Even in those cases in which an autopsy was performed the pathologist's report sometimes indicates that, if he had not been told what to find, he would scarcely have found it.

On looking up the general subject of status lymphaticus, I

find that this mysterious (I might almost say mystical) condition was only a few years ago used in precisely the same way, and with the same confidence, to explain another class of fatalities. It is less than a decade since the time when, if a patient died suddenly after a dose of antitoxic serum, an "unsuspected condition of status lymphaticus" was invoked as the explanation.[1] Nowadays, of course, we call such cases anaphylaxis, and never think of status lymphaticus as having anything to do with the matter. In many of the very best text-books of pharmacology (written, by the way, by laboratory men) the practice of occasionally interrupting the administration of ether and of allowing the patient to come for a few moments pretty well out of anesthesia, is expressly recommended. If anesthetists will only realize that this is a procedure which above all others should be shunned, the number of cases of so-called status lymphaticus under anesthesia will, I believe, show a sudden and marked decrease.

Let me quote a case which occurred as I was writing this paper. It was merely a tonsillar operation. Cocaine had proved ineffective in wholly overcoming the pain. The subject, an hysterical woman, was further excited by the sight of blood. It was decided to give a little ether. It was given. The woman promptly died, and all efforts at revival failed. In this case neither the patient nor her family nor the surgeon had, prior to the operation, the slightest suspicion of any cardiac weakness or disorder. It seems not to have occurred to the puzzled surgeon that he might allege an "unsuspected condition of status lymphaticus." In my opinion the reason that "unsuspected status lymphaticus" is so often invoked after tonsillar operations lies less in any connection of the tonsils with the thymus than in the fact that etherization is administered intermittently in such operations, and the subject repeatedly comes part way out of anesthesia.

I am aware that thousands of patients are treated as were this woman and the man in the cases I have instanced, and do

[1] Dr. J. S. Haldane, of Oxford University, tells me that "status lymphaticus" was formerly invoked also as the cause of caisson disease.

not die. The only comment to be made on this fact is that the same mathematics which attributes nine lives to a cat should credit an average of ninety and nine to a human being. Otherwise adenoid and tonsillar operations as now done would be rated as among the most dangerous in surgery, and excitable or alcoholic subjects an impossible risk. There are unquestionably individual variations among human beings, as among animals, in susceptibility to the dangers of anesthesia. Apparently some human beings are like cats in that the acapnia developed by unskilful anesthesia makes itself evident primarily in deleterious effects upon the heart. Such persons are prone to die of cardiac failure. In the majority of human subjects, on the other hand, the relative susceptibilities of heart and respiration are more as they are in the dog. In them respiration is the function which fails first. It is very fortunate that the large majority of human beings are more resistant to both forms of death than either cats or dogs. Otherwise surgeons would lead a far more troublous existence than they do.

What has been said thus far relates principally to only the earlier part of any prolonged anesthesia. There is, however, a point of similar tenor in connection with the termination of anesthesia. I learned of it from a man in whose experience and powers of observation you will have the utmost confidence—Dr. Alexis Carrel. At my request he has most kindly authorized me to quote from a conversation between us some months ago. I had stated that I had found dogs much less liable to sudden death under anesthesia if they were morphinized; that I attributed this to the influence of morphine in quieting the respiratory centre, preventing excessive breathing, and thus obviating acapnia. Dr. Carrel replied: "I do not give morphine. I use only ether; but I found a good while ago that my animals lasted much better if the mask used to etherize had a large dead space with a good-sized tube attached to the headpiece, so as to involve a considerable amount of rebreathing." Then he added, and this is the point which I wish especially to emphasize: "I have often observed after an operation, when the animal was

nearly out of anesthesia, that if I wished to put in just one more stitch or to make some other slight change, and again administered a little ether, the animal was very apt to die suddenly. Such cases are peculiarly difficult to revive."

In closing, I may say that I believe that these forms of death, and, in fact, by far the greater number of all deaths under anesthesia, are fundamentally due to acapnia resulting from the excessive pulmonary ventilation of the stage of excitement. The prevention of these fatalities lies in such measures as those which Dr. Gatch has found so successful in the Johns Hopkins Hospital. Apart from any theory or any particular technique, however, this point of supreme importance should be impressed upon every anesthetist and every surgeon: In prolonged light anesthesia and excitement, and especially in any intermittent method of administering ether or chloroform, peculiar dangers are involved.[1]

[1] For the details and analytical data of the experiments here referred to and for references to the physiological and pharmacological literature bearing on these matters, see the series of papers on "Acapnia and Shock," in the American Journal of Physiology, and especially vol. xxvi, p. 260. The detailed evidence regarding primary cardiac failure inducible in cats by means of ether will be printed in a later paper of the acapnia series.

NITROUS OXIDE ANESTHESIA AND A NOTE ON ANOCI-ASSOCIATION, A NEW PRINCIPLE IN OPERATIVE SURGERY.

By G. W. CRILE, M.D.,
CLEVELAND.

In the Ether Day Address delivered in Boston in October, 1910, I presented the arguments upon which a neutral surgical state of the patient can be maintained during certain operations —a state best described by coining a new word, viz., *anoci-association*. Operations performed under the state of anoci-association are free from shock. It is the purpose of this paper to take up certain of the practical applications of the conclusions of that paper.

I have thus far performed 10,787 operations under general anesthesia. Of these, 8375 were etherized and 2412 were anesthetized by nitrous oxide-oxygen anesthesia. There was no anesthetic death in the series. The nitrous oxide anesthesia was administered by the Teter apparatus. To this table I may add the table of Dr. C. K. Teter, whose anesthetics were administered with the Teter apparatus as follows:

Anesthesia up to five minutes	12,888
Anesthesia from five to fifteen minutes	3,365
Anesthesia from fifteen to thirty minutes	865
Anesthesia from thirty to sixty minutes	346
Anesthesia from one to two hours	228
Anesthesia from two to three hours	22
Anesthesia from three to four hours	2
	17,716
Personal cases	2,412
Colleagues at Lakeside	320
Total	20,448

In one of Teter's cases, a desperate one, the operation could not be completed by Dr. Rosenwasser, and the patient died on the table, though the anesthetic had been withdrawn for some time before.

I have now used under certain restrictions and in selected cases morphine and scopolamine as adjuncts to ether or nitrous oxide anesthesia in over 3000 surgical operations. In the very young and in the old, and in all cases in which there is an impairment of the brain activity, *e. g.*, when there is an increased intracranial pressure, profound hemorrhage, starvation, etc., in other words, senility, anemia, infections, and other conditions have already done what morphine and scopolamine do, viz., have depressed the associational power of the brain, I have not found material postoperative disadvantages beyond certain cases of morphine vomiting.

The shortcomings of nitrous oxide gas are as follows: It is the most difficult anesthetic to administer; its effects are fleeting; there is imperfect relaxation of the abdominal muscles; it is more expensive than ether; and there is more venous congestion. Though difficult to give, its administration is dependent upon simple rules which can be easily learned, but it should be given only by one gifted with a particular personal equation, viz., the anesthetist must be an individual of the keenest perception of the precise condition of the patient at every moment, *i. e.*, the anesthetist must be a most delicate human recording apparatus.

The expense may be reduced to about $1.25 an hour by manufacturing the gas in the hospital and piping it to the operating room. The muscular rigidity may be overcome by switching on the ether in a Teter apparatus until relaxation is secured, after which nitrous oxide alone continues the relaxation. The extent of increased venous congestion depends largely upon the administration of the gas. In abdominal operations the greater intra-abdominal tension makes it necessary to take unusual precautions in the management of the intestines. The advantages of nitrous oxide are: It is a pleasant anesthetic to take; it is a quick anesthetic; there is only occasional postoperative vomiting due to the anesthetic; it is to a certain extent a specific preventive of shock from the operation; there is no impairment of the immunity of

the patient, such as occurs in ether anesthesia; there being no cumulative effect, the anesthesia may be prolonged with less injury than with ether; it may be repeated as frequently and without objection as desired, and finally, when properly given, it has few contraindications.

We have evidence to show that nitrous oxide owes its anesthetic qualities to its ability to prevent the use of oxygen in the tissue. In association with Miss Menten we found that nitrous oxide blocked nerve conduction in a frog nerve muscle preparation when suspended in its pure vapor. We found also that a vacuum likewise caused a blocking of nerve conduction under similar conditions. Then we experimented with three types of animals. (1) Animals such as the mouse that cannot live beyond a few minutes without oxygen. (2) Animals like the frog that are able to live a considerable period of time with little or no oxygen. (3) Animals like certain beetles that require oxygen but have no hemoglobin. Individuals of all of these three groups were placed in a jar having been filled with nitrous oxide in one experiment, and in another experiment a similar group was placed in a vacuum. In both the nitrous oxide experiment and the vacuum experiment the results were identical, viz., the mouse was promptly anesthetized and died, the frog and the beetle even after an hour regained their normal state. From this experiment and from the phenomena of nitrous oxide anesthesia in man it is quite certain that its anesthetic properties are due to a partial deprivation of oxygen from the nerve cells of the brain, or at least the brain cells were prevented from using oxygen. In nitrous oxide anesthesia the blood pressure rises, the pulse rate falls, and the respiratory rate is increased. This is precisely the sequence of events in asphyxia.

Now, with this conception as to the physiological action of nitrous oxide in mind, a certain sequence of events which heretofore constituted the greatest difficulty as well as danger in the administration of nitrous oxide was at once understood and as easily controlled. This sequence is the following: While putting a patient under nitrous oxide anesthesia there is usually a marked increase in both the rate and in the depth of respiration. If the proportion of nitrous oxide and oxygen is left unchanged the patient becomes cyanotic, the respiration is labored, the pulse

slow, and in very faulty administration there are clonic muscular contractions. These are phenomena of anoxhemia of the brain. This deficiency of oxygen nature tries to overcome by increasing the activity of the respiration; but instead of this increased activity furnishing more oxygen, more nitrous oxide is inhaled which, of course, increases still further the oxygen deficiency and increases oxygen hunger, hence a vicious circle between the nitrous oxide bag and the respiratory nerve mechanism is established. Now, in the course of nitrous anesthesia, if at the moment there is an increased respiratory action—a specific warning—the nitrous oxide is at once turned off, the oxygen continued, and ether turned on, the respiratory activity will be immediately smoothed out and in the meantime there will be no loss, but a gain in the progress of anesthesia. In a minute or two nitrous oxide may again be turned on, the ether turned off, and the anesthesia goes smoothly on. This, indeed, is the key to the entire process. Everyone knows that the principal difficulties occur early in the anesthesia, and that after, say, five to ten minutes the anesthetic runs smoothly. It must be remembered that all inhalation anesthesia puts asleep only a portion of the brain and is at best only a veneer. Nitrous oxide is a thinner veneer than is ether. There is a very important surgical point that relates to nitrous oxide anesthesia—that is, rough surgery excites a greater involuntary reactive opposition of the patient to the surgeon than ether does. It is, indeed, a silent protest of the unconscious patient against physical injury. Those who wish to do rough surgery will scarcely find nitrous oxide suitable for their purpose.

Morphine and scopolamine have one physiological action, the importance of which has largely if not wholly escaped the notice of the pharmacologist whose knowledge of drugs is unfortunately too much limited to the experimental laboratory—that is, morphine and scopolamine depress the faculty of associative memory of the brain, and as such wholly or in part abolish fear. Under the influence of morphine, I am told by Prof. Mathews, the victims of the guillotine submitted without fear, while without morphine they often expressed their objections by physical resistance. Under the influence of morphine and scopolamine no one is a coward, no one is brave, everyone is in a neutral state.

We now know that fear alone may cause physical damage, not alone to the brain, but to other organs. It causes an increase in adrenalin, in the output of glycogen, inhibits the activity of the entire digestive mechanism, and in rabbits repeatedly frightened albumin and casts are sometimes produced. In the 2412 personal cases in which the morphine, scopolamine, and nitrous oxide anesthesia and anoci-association methods were used in various combinations as indicated in a general surgical service, the percentage of patients discharged from the hospital as dead was 1.9 per cent. This result I have not been able to equal under former methods.

Combined with this method of anesthesia there has also been developed a gentle technique and a more careful management of patients from the time of their entrance to the hospital until their discharge. The one feature of extraordinary interest is the fact that approximately 90 per cent. of these 2412 patients have no unpleasant recollections of their operations and the post-operative nervous impairment has been strikingly reduced.

Leaving now the consideration of the use of general anesthetics and narcotics, I will again refer to the new principle of operative surgery which can be expressed only by coining a new word. Since the response of motor organic life can be made only by phylogenetic association, it is obvious that there must be two great classes of association, viz., those that are injurious and those that are beneficial. The injurious kind are called noci-association, *i. e.*, nocuous or injurious associations. Without repeating at this time the arguments in support of it, we will assume that the injury to the nervous system indirectly in contradistinction to the gross physical injury directly done in the course of surgical operations is due to fear and to the nerve impulses set up by injury of sensitive nerves or noci ceptors in the course of operation. It may be an unpleasant thought that although our patient is unconscious from general anesthesia, the nerve impulses inaugurated by operative injury of the nerves reach the brain and influence it by phylogenetic association, making a reactive opposition to the surgeon—an attempt to get off the table and escape from the injuries the surgeon is inflicting. There is convincing evidence of this proposition, and every surgeon can recall instances in

which the combination of light anesthesia and perhaps vigorous surgical procedure have elicited an unmistakable, perhaps even a vigorous attempt at escape from the table. Figuratively speaking, what must be the suffering of that part of the brain which is known to be awake during anesthesia? It is clear that if general anesthesia cannot prevent the damage done to the brain in the course of operations, how can such damage be prevented? In 1897, while engaged in a research on surgical shock, I discovered that cocaine in addition to its previously known ability to block sensory impulses, also blocked the impulses that cause the response of the entire nervous system from injury under general anesthesia. If one combines a complete local anesthesia with a general anesthesia and avoids fear, then it matters not how poor the risk, nor how extensive the operation, the nervous system is wholly protected and the immediate operative risk is wholly eliminated. Though the researches upon which this is founded may seem to be somewhat speculative, no one who has witnessed the astonishing immunity that is conferred upon the patient by this method could doubt the correctness of the premises. The most striking results are achieved in the operation for Graves' disease. There is probably no greater difficulty from the standpoint of the conservation of energy of the patient in any field of surgery than in the operations on intensely explosive cases of Graves' disease. Under anoci-association cases of severe Graves' disease may be anesthetized in their beds, conveyed to the operating room, and the gland excised without causing any change in the general condition of the patient at the close of the operation. Our standard is that at the close of the operation the patient's condition should compare favorably with the condition when in bed the day before the operation. The later reaction from the wound itself, and the metabolic alterations from removal of the gland do not here enter. We have lately found that the patients may be anesthetized in their rooms with nitrous oxide even more successfully than with ether. In this manner the brain, that is in this disease pathologically sensitive to pain, is maintained in a negative state throughout the operation. The exclusion of fear and of trauma from the brain prevents any nocuous associations. This state can, as I believe, be best expressed by coining

a new word, viz., *anoci-association*. Operations in neurasthenic subjects under anoci-association preserves the nervous system in a remarkable degree. Then, too, if second operations are required, the beneficent first experience gives a splendid background for the second.

Now, I am ready to admit that to accomplish this it is necessary to especially train the nursing department, the hospital staff, the anesthetist, and above all to train one's self to act with the greatest precision and only in the interest of the patient, and also I must admit that it immensely increases everyone's labors.

Could there be discovered a method of spinal anesthesia that one could use without reservation in the Trendelenburg posture, the entire question of shockless operations upon the abdominal viscera would be solved. However, the remarkable protection that nitrous oxide exerts in the prevention of shock, as shown by a study of the slight changes in the brain cells in trauma under nitrous oxide as compared with ether in animals, as well as a study of 2412 clinical cases, in a measure minimizes the importance of nerve blocking in the operative field. On the theory that nitrous oxide owes its anesthetic property to its power of limiting oxidation in the brain tissue, and the theory that shock is due to an exhausting activity which is accomplished through oxidation processes of the brain cells due to injury, one might very properly infer that the brain cells were by nitrous oxide prevented from making the harmful expenditure of energy, thus minimizing the shock.

Whatever the explanation, the wonderful clinical results of operating under the condition of anoci-association is an established fact, and has placed in the hands of surgeons an added resource which will reclaim many risks hitherto thought to be hopeless, and in favorable risks there is added safety, diminished postoperative impairment, and the operation itself is robbed of most of its terrors.

UNINTERRUPTED ANESTHESIA IN OPERATIONS ON FACE AND MOUTH.

By EDMOND SOUCHON, M.D.,
NEW ORLEANS.

I HAVE seldom met conditions that have worried me more than to have to operate on the mouth, nose, or face with a patient imperfectly anesthetized. Therefore, some years ago, I devised a small apparatus for the purpose of keeping up the anesthesia uninterruptedly by introducing a rubber tube into the throat through the nose or mouth. I called it the "anesthetizer," and Tiemann, of New York, made it for me. From that time on I never had any trouble on account of anesthesia when operating on the nose, mouth, face, or even the neck.

The apparatus consists of a glass cylindric receptacle with a frame supporting a ring *A* for the thumb and a rubber bulb *B* so that it can be worked with one hand. From the bulb originates a rubber tube *C* wrapped with coiled wire to prevent it from bending. It ends in the inlet tube *D*. Just at the point of junction or *E* is a ball valve which prevents the liquid anesthetic from entering the bulb when the pressure upon the latter is released. The inlet tube extends through the liquid anesthetic to the very bottom; its lower end is bevelled to prevent the orifice being stopped by coming in contact with the bottom of the receptacle.

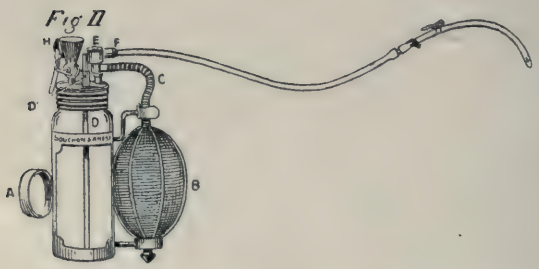
There is a circular line on the receptacle showing *how much, and no more*, liquid anesthetic should be poured in without running the risk of injecting liquid anesthetic through the outlet tube. The quantity will suffice to keep a patient anesthetized

for nearly two hours with chloroform alone, and about one hour with ether alone.

The receptacle is closed by a metallic lid that screws around its neck; a washer makes it air-tight.

From this lid springs the metallic portion of the outlet tube *F*. It originates directly from the under surface of the lid. After a

SOUCHON'S IMPROVED ANESTHETIZER



very sharp curve of 90 degrees, it terminates by an orifice to which is attached a rubber tube, long enough to enable the anesthetist to hold himself well out of the way of the operator. This tube is provided with a clasp seven inches from the extremity that clasps the nostril and holds the tube in proper position. The lid is provided with a funnel through which the anesthetic is poured into the receptacle. To the edge of the funnel is

adapted a clasp with a long arm that answers for a hook by which the apparatus can be suspended through a button hole: the clasp is to catch on to the cloth of the gown when there is no button-hole for the hook. Thus the anesthetist may have both hands free, resting or helping for a while.

Patient should be first thoroughly anesthetized by any of the ordinary methods; the face-piece is then removed and the tube of the anesthetizer is introduced as low down as the *lower pharynx*. By compressing the bulb the apparatus is set to work. The bulb should be compressed gradually, not jerkingly. By compressing the bulb more or less quickly, and thoroughly, the amount of anesthetic is graduated.

It takes very little anesthetic to maintain anesthesia after a patient has been thoroughly anesthetized.

The apparatus works very well also when the head is lowered, or in the Rose position.

The lower end of the bulb is so arranged as to allow it to be connected with a piece of tubing leading to a bag of oxygen, if desired.

I believe that this apparatus is the only one with which there is no risk of injecting liquid anesthetic into the pharynx, regardless of the force applied to the bulb. Its safety, simplicity, compactness, portability, efficiency, and easy management speak for themselves.

Many details concerning it can be found in the *Medical News*, Philadelphia, November 23, 1895.

DISCUSSION

Dr. John B. Roberts, Philadelphia.

I have only five things to say: (1) Death from general anesthesia usually is due to poisoning and the result of incompetent administration. This has been pretty well established by the papers just read. (2) The patient should not be killed by the anesthetist, but he should be almost conscious when the operation has been completed. (3) Poisonous agents administered for any purpose should seldom be intrusted to non-graduates. This is shown by the physiological papers read today. If it is necessary under unusual circumstances to break this rule, there should then be medical supervision by some graduate of the state of the patient during the use of the anesthetic. This applies to nurses as well as to undergraduates. (4) The hypodermic administration of morphine and atropine is well known to be in ordinary cases practically free from danger. Such medication before giving ether lessens fear, absence of which we have been shown by Dr. Crile is an important factor in anesthesia. It lessens the amount of anesthetic required. The value of its use preliminary to general anesthesia was proved by Claude Bernard thirty years ago and has been established by many surgeons since that time. It is of great advantage even in abdominal cases. Finally, (5) complicated apparatus for producing the anesthesia does not appeal to me. The simpler the apparatus, the more experience on the part of the anesthetist; and the more skill in his methods, the better as a rule will be the general use of anesthetics. The average practitioner cannot have at hand complicated apparatus, and perhaps could not use them if he could have them. Sometimes, therefore, complications add to the danger of the administration. To my mind pouring a little ether upon a few layers of gauze and then covering this with a closely woven towel to prevent too rapid loss of ether upward, increasing as it does the CO_2 rebreathed, is the simplest, best, and most generally useful method of producing surgical anesthesia.

Dr. Charles A. Powers, Denver.

For many years I have been intensely interested in the subject of anesthesia. I have been more than interested in the splendid papers of this meeting. With the paper by Dr. Bevan I am absolutely in accord in every particular. Dr. Gatch, I think, spoke of the lighting up of a general tuberculosis after the administration of ether. Here in Colorado we have many tuberculous patients. In my own practice

ether, as a rule, is the anesthetic for these patients, and I personally have not had the experience of which Dr. Gatch speaks.

In the present state of our knowledge I believe that ether, given by the drop method, is our safest and most desirable general anesthetic. There are comparatively few cases in which it is not well tolerated when carefully given. For the last fourteen years I have consistently advocated the employment of a special, skilled anesthetist, and have constantly employed such an one in my private practice. I have been fortunate in having had the same anesthetist during this period, a man of mature years, who has devoted special attention to the giving of anesthetics, and who has no interest in the operative work of surgery other than such as may attach to seeing a patient safely through a given operation. Applicants for positions in surgical departments do not make the best anesthetists; they are too much interested in the operations themselves.

When possible, my anesthetist invariably examines a given patient one or two days before operation. He obtains the history, he makes a thoracic, and, when necessary, abdominal examination, he examines the urine, and, when necessary, the blood. He learns the nature of the operation to be performed, and approximately its duration. In a word, he familiarizes himself with all of the aspects of the case. When he gives the anesthetic he knows the patient and the patient knows him. I am convinced that the patient is less apprehensive under these circumstances, he or she feels that the matter of anesthesia is being given careful attention. The psychic shock is lessened, the importance of which was emphasized by Dr. J. Bapst Blake at our meeting two years ago, when he spoke of diminishing to a minimum pre-anesthetic fright, apprehension, and intense emotion, for the sake of the patient's safety as well as comfort.

I am rather apprehensive regarding the administration of the ethyl chloride compounds, and do not permit them to be used by any but highly skilled anesthetists.

This important subject is quite too broad to permit of more than fragmentary comments. One difficulty which I have constantly experienced in our hospitals is that of having a patient sufficiently protected from cold before, during, and after operation. A miner comes down from the mountains for, let us say, a hernia operation. The man is in the habit of wearing one or two heavy woollen undershirts day and night. This may be wrong, but he does it. He is put to bed in a hospital ward, stripped of his underwear and clothed only with a thin cotton semblance of a garment. Beneath the cotton bed sheet there is probably a rubber draw sheet, the head of the bed is placed under an open window, the patient "catches cold" during

the night. He is given the anesthetic the next morning after being wheeled through drafty corridors. He is fortunate if pneumonia does not follow.

Our patients should wear, approximately, while in bed in the hospital, the clothing in which they are accustomed to sleep when at home. They should be scrupulously protected before, during, and after the anesthetic. The entire matter of anesthesia should be made the subject of careful study at the hands of men or women especially adapted, temperamentally, to its administration. It should not be made, as is so often the case, a matter of chance.

Dr. Howard Lilienthal, New York City.

I have ventured to arise to address you because I know something about the actual working in the human subject of intratracheal anesthesia, and I feel it my duty to give my impressions of this method of ether administration. I watched with great interest the work of Meltzer and Auer and its development with animal subjects by Carrel. My associate at Mt. Sinai Hospital, Dr. Elsberg, devised an apparatus for the application of this method in human beings, and after careful experimentation the first patient upon whom it was used was a woman just dead of myasthenia gravis who was kept *apparently* alive for several hours by the intratracheal insufflation of air. The instrument being withdrawn, the woman died. The first patient that came to us for operation where we thought it safe and proper to try this method was a man who had a chronic abscess of the lung. The case has been reported in the *Annals of Surgery*, 1910, the operation, done in February, 1910, being the first performed on a human being under this form of anesthesia. He was a thick-necked, apoplectic-looking individual, and about the worst sort of a patient for any form of anesthesia you could imagine. He was coughing large quantities of mucopus, and during the preliminary anesthesia, which was induced by inhalation in the usual manner, he rattled with tremendous stridor, became cyanosed, and his condition was truly alarming. Dr. Elsberg inserted the cannula into his trachea with considerable difficulty, but the instant it was in place and the air and ether were blown through the apparatus, he became perfectly quiet. The motions of respiration were about 7 to the minute, he became pink, and I opened his right chest with the greatest ease and without the patient's exhibiting any untoward symptoms. By running up the pressure of Hg in the manometer you could bring his lungs down to fill the chest cavity completely, or by reducing the pressure you could draw the lungs up farther and farther until they receded from the diaphragm, exposing that muscle

to view. Nothing intrathoracic could be done for the abscess because of dense adhesions of the upper part of the lung to the chest wall, and I closed him up again. He got well without a single symptom, and apparently was cured of his abscess, but died a few months later from an acute pulmonary hemorrhage. I have had an experience with over 60 cases, most of them anesthetized by Dr. Elsberg, some by myself, while another did the operation, and some were supervised by the members of the house staff after the tube had been put in. The operations were for the usual run of surgical diseases. I have noted the following:

The patient is absolutely quiet in this anesthesia. There is no rattle or stertor. The respiration may be regulated as to rate even to the point of producing apnea for a minute or more at a time, though this is not recommended as a routine. In abdominal operations it is not so easy to maintain complete relaxation. Unconsciousness is complete and there is no struggling, but rigidity in certain individuals has proved an annoying symptom. In operations about the head intratracheal insufflation is an ideal method of narcotization, as also in goitres and other neck operations, for the breathing motions are minimal and swallowing is almost absent. I have seen the patient apneic and as quiet as if he were in a trance, the spurting vessels giving the only striking sign of life. It is ideal in all operations upon the intrathoracic viscera.

Dr. Leonard Freeman, Denver.

Here in Colorado considerable of our operative work must be done on patients having either active or latent tuberculosis. I wish to add my testimony to that of Dr. Powers, that we give them ether with perfect confidence, except in cases where the tuberculosis is active, or far advanced, and we see very few ill effects. Whether this is due to the inhibitory influence of the climate and altitude or because ether does not in general disturb these cases, I am not in a position to state.

Dr. Fred. B. Lund, Boston.

I want to add one word about local anesthesia. I refer to local anesthesia in strangulated hernia. There is no way of giving a general anesthetic in strangulated hernia where the patient is constantly vomiting brown fluid, unless the intratracheal method would do it, without danger of the patient inhaling some of the vomitus. Strangulated hernia has lost its terrors since operations have been performed under cocaine in the conscious patient. The average age of the patient is pretty old, from seventy to eighty in my cases of late.

You can do your operation under local anesthesia, and if you have to resect a bit of gangrenous bowel there is no sensation and no shock. I have done this in a woman, aged seventy-five years, who ten days before had had hemiplegia, and she had a fine recovery. The mortality in strangulated hernia is almost nothing since we have adopted the local anesthesia. I think we ought to think of this.

I think every word Dr. Lilienthal has said about insufflation anesthesia is true, and that it will be very valuable in operations about the head and neck. I have recently used it for removal of cancer of the tonsil and glands of the neck, in which the side wall of the pharynx was affected clear down to the hyoid bone. The jugular vein was removed. The insufflation anesthesia was given through a tracheotomy tube. It was a long operation, yet the blood remained perfectly clear; there was no cyanosis and no shock, and by blowing a little air in at the end the patient quickly returned to consciousness.

I think spinal anesthesia has a definite place in amputation of the legs in diabetic patients.

Dr. Charles N. Dowd, New York City.

I would like to add a word to those by Dr. Lilienthal regarding the apparatus of Elsberg. It has been used in our hospital thirty times, although I have used it only a small number of these. An anesthesia two days ago illustrates the kind obtainable by this method. This particular man was a thick-necked individual requiring an extensive neck operation extending over two and one-quarter hours. During this time he lay on the table with quiet respiration, blood of the right color, without an indication of a movement excepting in respiration, without any of that collection of saliva and mucus in the throat which patients so often have during anesthesia, and the anesthesia seemed perfect. After the operation was completed he quickly became conscious, was almost free from nausea, wished to sit up in bed when the bandage was adjusted later in the day, and the next day wished to be out of bed. This is not an isolated case, but corresponds closely to the others. We feel that the method is most valuable and should have extensive and careful trial.

With regard to one or two other points. I am very glad that the question of "status lymphaticus" has been brought up. Most of the deaths which have been reported as due to "status lymphaticus" have been in children. Children are particularly susceptible to anesthesia; it is not very uncommon that a person who is skilled in giving anesthetics to adults will anesthetize a child so deeply that he will almost stop breathing. Children pass very quickly from a moderate to a most profound degree of anesthesia. If the anesthetic is with-

drawn in time the surgeon may operate ten or fifteen minutes without further anesthesia. I do not know whether this sudden profound anesthesia is due to a paralysis of the centre in the medulla or not, but it is a clinical fact. If the anesthetic is not withdrawn in time a fatality results and one may suspect that this result has sometimes been ascribed to a so-called "status lymphaticus."

As to the method of obtaining good anesthesia. The problem is a practical one which most of us are still struggling with. Fortunately the time has now passed when it was the general custom for uninstructed junior internes to administer anesthetics. At the present time most of us meet the problem by one of two methods; either by having the junior internes properly instructed, or by having nurses, sisters, or women who will stay in the hospital for long periods properly instructed in the administration of anesthetics. Personally, I have seen the best results where a sister has been thoroughly instructed and has given the anesthetic for months and years. It is hard in many parts of the country to get this system introduced; hospital managers feel that they are better protected if the anesthesia is given by graduates in medicine. If, however, this Association at this time should approve the proper training of women anesthetists, it would be easier for hospitals throughout the country to obtain the advantage of this type of skilled anesthetist.

Dr. Joseph Ransohoff, Cincinnati.

The paper by the Professor of Physiology of Yale has confirmed me in the conviction I have long entertained that the question of anesthesia can never be settled outside of the physiological laboratory. We are often charging deaths on the operating table to anesthesia, when in reality it must always remain a question in the mind of the operator whether the death was really the result of the anesthetic. The only death that I would consider absolutely with justification attributable to anesthesia is the one occurring before the surgeon has used the knife and before he has applied a ligature to any vessel. Sudden deaths occur in various walks of life without known cause; why should not during operation a death occur without at once attributing it to the anesthetic used?

I was very much interested in Dr. Gatch's paper, in which he stated that three or four weeks after the cervical glands were removed the patient died from pulmonary tuberculosis.

We are in the habit, I fear, of either praising something to the skies or knocking it on the head for good, and that is now the case with spinal anesthesia. I am sorry that Dr. Bevan puts a quietus on spinal anesthesia. I have used it a great deal, and I know of

nothing more brilliant than to have a man along in years, with a heart which you would not intrust to chloroform or ether, with bad kidneys, having his prostate removed while smoking a cigar; I know of nothing more satisfactory to both patient and operator than to remove the thigh of a man with diabetic gangrene, unsuitable for ether, under spinal anesthesia. Some years ago at the surgical meeting in Washington, the late lamented Senn read a paper on Colostomy. He said, "Colostomy is dead." Durham, of Guy's Hospital, later said: "Gentlemen, colostomy may be dead with Senn, but it is not dead with me; I have done hundreds of colostomies, I am doing them now, and I assure you if the proper occasion arises I shall do a colostomy again." That is exactly my position in regard to spinal anesthesia. It has a limited field, I am willing to admit, but should my time ever come when my heart is bad and my kidneys refuse to act, and I happen to get a senile gangrene that requires amputation of my thigh, I want to see that operation go on and enjoy my cigar as I do this minute.

Dr. Thomas W. Huntington, San Francisco.

I think it was four years ago that I spoke enthusiastically upon the subject of spinal anesthesia, and I rise now to modify the statement then made, but still to strengthen the statement made by Dr. Ransohoff, because I personally, while not using it as often as I did, still find great comfort from it, and I am sure my patients get greater comfort than I do. The class of cases just recounted bear it very well. They come through it without shock (*i. e.*, people of seventy-five, eighty, and upward), and usually spend a comfortable night after the operation. On the other hand, it must be remembered that the death rate from spinal anesthesia *as a routine measure* is such as practically to put it out of business. It should be strictly limited to those cases where there is great danger from the general anesthetics, yet where operation demands anesthesia.

Dr. Robert G. Le Conte, Philadelphia.

I, also, would like to say a word with regard to spinal anesthesia. About seven years ago one of the surgeons of the Pennsylvania Hospital brought from Europe one hundred or more capsules of stovain, which was used rather routinely for perhaps 60 or 70 cases, in order to find out the value of the method. Its use has now been discontinued except in certain selected cases. One of these I had two weeks ago, a man, aged sixty-five years, very stout, who for forty years had been a free liver and a very free consumer of alcohol, with a bad heart, a good deal of albumin, casts, and sugar

in the urine, and diabetic gangrene of the foot and leg. I gave him spinal anesthesia. He was totally unconscious of the midamputation of the left thigh, chatted freely during the operation, and the pulse rate did not vary two beats during the procedure. There was no shock whatever. His recovery so far has been uninterrupted. We all acknowledge that spinal anesthesia has a limited field, but in cases of the above class, where a general anesthetic is contraindicated on account of the condition of the heart and kidneys, spinal anesthesia will often work like a charm.

Dr. Arpad G. Gerster, New York City.

I have been brought up in the chloroform school, and for many years, I think for about sixteen, I have been in the habit of using chloroform routinely in my hospital practice. During that time I became convinced of the facts brought before us by a number of the gentlemen who spoke on the subject today, that the danger of chloroform outweighs that of ether on account of the danger which lies in the uncertain and unreliable method of administration to which we had to submit in our hospitals because of the facts laid before you, namely, that the governors of the hospital will not grant the expense of special anesthetists. In Mt. Sinai we had the same difficulty, and it required a fight of a number of years, until finally the governors granted the request of the medical board, and we now have specially trained and paid anesthetists. Knowing this great danger, I gave up chloroform and restricted its use to those cases in which it is especially indicated, that is, where other forms of anesthesia are contraindicated.

Dr. Bevan gave an admirable exposition of the status of anesthesia from the standpoint of the practical view. I agree with him with the sole exception of his too critical negation of the usefulness of the spinal anesthesia, which I use but rarely, yet when we need it we find it extremely agreeable to command its use. I therefore would recommend its being retained in the armamentarium.

The most important part of the discussion, I think, hinges upon the papers by our physiological friends. It is an underlying desire of the human intelligence not only to hear what method is the most successful, but it also craves to know the why and wherefore of the success. At first there seemed to be a certain contradiction in the views of Dr. Crile and Dr. Henderson, but the contradiction is not real, and is but a seeming one. These theories do not contradict each other, they rather complement each other.

In my student days in Billroth's clinic we were taught to be careful in administering an anesthetic to people who were afraid. The fact was well known to all surgeons from the beginning of anesthesia,

and I have often called the attention of my assistants and students to the circumstance, that those suffering from any form of nervous exhaustion, and among these especially men exhausted by sexual excesses and masturbation, made dangerous subjects to anesthetize.

Mr. Harold J. Stiles, Edinburgh.

The papers just read have been most instructive and illuminating to me; I believe they will create a new epoch in the history of anesthesia.

With regard to Dr. Bevan's paper, it was a model of judicial summation; in fact, when Dr. Bevan read his paper I felt that he had mistaken his vocation, famous as he is. He gives a splendid review of the present position of anesthesia, but I do not believe for one moment that what he said this morning will hold true a few years hence. I am certain that we are going to advance very materially, and I say so as the result of what I have seen during the few days I have been in America.

First, with regard to specialists in anesthesia. This is a subject which touches me especially, because when I was appointed surgeon to the Royal Edinburgh Hospital for Children we had no anesthetist, and time and again I was obliged to appeal to one of the visitors who happened to drop into the clinic to kindly give the anesthetic because I needed the resident to assist me at the operation. I therefore went to the directors and pointed out to them that I could not operate under such conditions. They provided me with a special anesthetist.

I think it is necessary to say a few words in defence of chloroform, and I am all the more pleased to have the opportunity of doing so before an American audience, because I think Americans have been a little too hard upon chloroform. My feeling is that if American surgeons had had the training in the administration of chloroform which some of us have had, they would use it in special cases with advantage. I think Dr. Mayo and those who visited the Children's Hospital at Edinburgh, during the recent meeting of the Clinical Society, would have little fault to find with the anesthesia as used there; it was largely chloroform, given by a specialist (Dr. McAllum) who is not afraid of chloroform. The paper of the distinguished physiologist, Dr. Henderson, interested me more than I can say. He gave me the explanation of why it was that it was safer for the patient to have the chloroform administered by a man not afraid of it. I think it is a good thing, and advisable in this country, that ether should take the place of chloroform; and if you will allow me to say so, I think this because you are afraid to give enough of the

drug. If you are afraid of it, and give it intermittently, you will get the results which the physiologist has mentioned. I have seen such results. I well remember a practitioner giving chloroform for me to a patient undergoing excision of the breast. He said he always allowed the patient to "come out" occasionally. The consequence was the patient was constantly getting into a faint condition and vomiting, due to the acapnia. When that condition is produced the minimum lethal dose of chloroform is reduced to zero and the patient dies.

This same condition may also be produced by violent respiration. I was always taught that the moment the patient begins to struggle violently we must at once stop the chloroform and give him a breath or two of air. I well remember walking into a German clinic for the first time one summer morning. The chief being away, I was introduced to the first assistant, who was just about to operate on a large hematocele, the patient being a man, aged twenty-one years. His wife and child were sitting in the corridor. Chloroform was the anesthetic used. The patient began to struggle; instinct caused me to remove the mask from the patient's face. The surgeon looked up, surprised and annoyed at the interference. The patient turned suddenly pale, and died.

Now, I am free to confess that since I visited Dr. Mayo's clinic five years ago I have become a partial convert to ether. I now use it in 75 per cent. of cases, because I recognize that it is safer than chloroform. I explained the method to my anesthetist, Dr. McAllum, a very able and persevering man, and he has mastered it thoroughly. Occasionally, however, we get a Scotchman who is in the habit of drinking a bottle of whisky a day, or a drayman working in the brewery, who cannot be put under by ether. Chloroform is the proper anesthetic in such cases.

Personally, then, I am not afraid of chloroform on the operating table if it is given by a man who knows how to give it; I am, however, afraid of its after-effects. I have had about 12 cases of delayed chloroform poisoning. I well remember the first case, a girl, aged ten years, operated on for hernia. The operation took five or ten minutes. The same night she became delirious; the pulse ran up, and she had hemorrhagic vomiting; the next day delirium and jaundice, and death. Postmortem there was a characteristic condition which once seen can never be forgotten—acute fatty degeneration of the liver, fatty degeneration of kidneys, of involuntary muscle, of the endothelium of the bloodvessels of the brain, and of the stomach. I came to the conclusion that delayed chloroform poisoning was more likely to occur in patients suffering from some form of general toxemia. There-

fore I made it a rule in the hospital that no patient suffering from toxemia should get chloroform.

Some years ago, in conjunction with Dr. MacDonald, our Pathologist, I read a paper on Delayed Chloroform Poisoning before the Society of Diseases of Children, Sir Watson Cheyne being in the chair. The criticism was that the condition had nothing to do with the chloroform, but that it was due to sepsis. Now, what is the relation between delayed chloroform poisoning and sepsis? If the sepsis originates in the abdomen, the liver has to deal with the poisons. Suppose we remove a gangrenous appendix under chloroform; what happens? The bacterial toxemia is intensified by the chloroform, which is the last straw, and the patient dies. That, gentlemen, explains the better results formerly obtained in America by those who used ether in cases of acute suppurative appendicitis and peritonitis. The moment I stopped giving chloroform in acute appendicitis my results showed a very striking improvement.

There are certain conditions, however, in which I think chloroform is indicated; for instance, in alcoholic patients, in operations in which there is likely to be considerable loss of blood, and in operations in which it is important to work with haste. Personally, I always use chloroform in breast cases in preference to ether, because there is but half the amount of bleeding, and consequently the operation can be done comfortably within an hour.

I think Dr. Bevan was a little hard on special apparatuses for giving anesthetics. My feeling is that if by these special apparatuses, even though they are a little cumbersome, we get a better and safer anesthesia, then it is our duty to employ them; and all the more so now that we have specialists to use them. There is just as much reason why we should use a special apparatus to give an anesthetic as there is for using special instruments for plating fractures of the femur. I believe, as I said before, we are entering a new era in the administration of anesthetics.

It has been my privilege to see Dr. Elsberg's apparatus used in Dr. Meltzer's intratracheal insufflation method of administering ether, and I was very much impressed; it was the simplest, smoothest, and most delightful anesthesia I ever saw. The patient, a child with tuberculous glands in the neck, operated on by Dr. Dowd, appeared to be in a trance; there was no movement of the chest; the head was slightly dependent; there was no cyanosis. I was also very favorably impressed with the nitrous oxide and oxygen anesthesia which I saw both at Johns Hopkins and at Dr. Crile's clinic.

There is an important point which I wish to bring before you, and that is that in the old country no one but a qualified practitioner is

allowed to give an anesthetic. No nurse, however well trained, is allowed to administer the anesthesia. Now, it would strengthen our hands if you gentlemen in America would grant a special certificate or diploma to those nurses who have had special training in the administration of anesthetics. I presume you give them a nursing diploma, and I see no reason why those who are qualified should not also have added to that nursing diploma a special diploma; or, what would be still better, give them a diploma for anesthesia which will qualify them as anesthetists without compelling them to go through a nursing training. If this plan were adopted in America it would greatly help us in legislating for a similar custom in our own country.

Dr. Bevan. I have nothing to add except to repeat what I said at the close of my paper. That I believe the time has come when we should insist upon having trained professional anesthetists. I do not know how this could best be emphasized by this Association, but if it were possible for us to take some action which would carry weight with the governors and managers of the hospitals throughout the country which would lead to the general adoption and recognition of the trained professional anesthetist, I think it would be very well worth our while.

Dr. Moore. I wish to congratulate this Association and Dr. Bevan on his most masterly paper, with which I am most heartily in accord. My very brief paper was simply a confession of faith and to put myself on record before this Association, for I realize that I have for many years been looked upon as an advocate of chloroform very justly; I am not ashamed of that record, for it was a good and honest one, but in this paper I have tried to point out why I had a change of heart. My environment has changed, and I found that the weight of evidence was very much in favor of ether, and I therefore felt I had no longer a moral right to maintain my position with regard to chloroform. The one thing which has prevented progress in this matter more than anything else is because we have all been prejudiced. I felt about chloroform as you did about ether. I was not afraid of chloroform, as Mr. Stiles said, and was more particular in choosing my anesthetist. In changing my mind statistics have had very little bearing, because I have known how statistics, both for ether and chloroform, have been made. I often think of a remark I once heard by a former Fellow of this Association; he said: "Figures do not lie, but we must admit they at times become damned enthusiastic."

With regard to a type of anesthesia with which I have had a limited experience; that is, venous anesthesia. In a case of double amputation

below the knee in a man whose feet were burned off by a forest fire, the extremities were emptied of blood by a rubber bandage, an opening made in the vein, and with a powerful syringe a sufficient quantity of 0.5 per cent. of novococain was forced against the valve, so that in a limited area of the limb between the rubber bands the parts were completely saturated. All told, in that particular case we used 120 c.c. of 0.5 per cent. novococain. Then just before removing the constricting band above I took the precaution to introduce some saline solution. The patient felt nothing of the operation, and thirty minutes after leaving the operating room he was eating his dinner sitting up in bed.

This method can be employed when a general anesthetic is impossible.

Dr. Gatch. I wish to correct a misunderstanding in regard to the simplicity of the apparatus I have shown. Its parts have been reduced to the smallest possible number and its use is easy, because the mask can be kept in place practically without attention, and because the mixture of gases is administered in a series of doses, each of which the patient rebreathes for three or four minutes. The anesthetist can therefore devote his entire attention to the color of the patient and the character of his pulse and respiration.

A point in regard to Dr. Henderson's theory. If a hypercapnia, or excess of CO_2 in the blood, prevents shock, you should not see shock in patients anesthetized in the manner I have described. Recently I administered nitrous oxide with oxygen for an interscapulothoracic amputation of the arm. During the division of the brachial plexus there was no change whatsoever in the pulse or respiration, a fact which would seem to support Dr. Henderson's theory.

Rebreathing will elevate the body temperature 0.5° to 1° in the course of thirty minutes. This is certainly a valuable means of preventing postoperative trouble.

In regard to the injurious effects of ether on patients with pulmonary tuberculosis, I can say that I have conferred with several gentlemen who have had an extensive experience with this disease, and have found them all very much opposed to the use of this anesthetic for consumptives.

Finally, I do not wish to assume the position of an opponent to the open method of giving ether. We use it in perhaps 25 per cent. of our cases.

Dr. Henderson. I want to recognize very frankly that there are cases which do not agree with my theory. I realize that it is largely

a matter of courtesy on your part that many of you have not reported such cases during this discussion. Not all deaths under anesthesia fall under my theory. In every new field one of the difficulties is to say, "Thus far and no farther." I am, therefore, very desirous of obtaining detailed reports of cases which seemingly disagree with my theory. In this matter I must appeal to you for help. Will you not, all of you, do me the favor of sending me reports of such cases; that is, of patients dying under anesthesia who do not seem to fit my hypothesis? I assure you I would very greatly appreciate it, and it would greatly help in the final working out of the acapnia theory.

Finally, I want to thank you for the honor which you have done me by inviting me to take part in this discussion. For a man who, like myself, leads the secluded life of the laboratory it is the greatest stimulus to meet with such a set of practical men as this Association, pulsating with life, energy, and progress.

Dr. Crile. First, I want to express my personal appreciation of the presence here today of Professor Henderson. His paper is illuminating and stimulating.

I do not wish to be understood as being in any way an opponent of the ether anesthesia. Ether is not an ideal anesthetic, as everyone who has taken it will attest. Dr. Bevan, in his masterly summing up of a vast amount of evidence, reached the conclusions that nitrous oxide is the safest and the least offensive anesthetic. Dr. Bevan later advises nitrous oxide in the most serious risks—cases in which ether could not with equal safety be given. If nitrous oxide is to bear the brunt of the heaviest risks in surgery, what can be the objection to giving the remainder of the patients the advantage of this method as well? For myself, I feel that it is an anesthesia which must be given only by one thoroughly trained and in daily practice. The surgeon is, in some operations, until he has adjusted himself to it, somewhat handicapped, especially in abdominal operations. When the muscular relaxation is incomplete, the addition of ether for a few minutes will produce complete relaxation. This is done by the Teter apparatus by merely turning a valve. The objection to Dr. Bevan's recommendation of giving nitrous oxide when ether is not so safe, is that by so doing both the anesthetist and the operator will lose their highest efficiency. There is no question but that an operative service under nitrous oxide requires a greater amount of training than an ether clinic; but why not pay the cost if thereby the risk is reduced and the ordeal is diminished?

Dr. C. B. G. de Nancrède, Ann Arbor.

I would call attention to one or two points overlooked in this discussion. After considerably over forty-two years' experience with anesthesia I have no hesitancy in saying I prefer ether to any other anesthetic; but I do not confine myself in my practice only to ether; I use chloroform and nitrous oxide gas, and gas and air, or gas and oxygen, even for major, prolonged operations in selected cases. I was waiting yesterday to see whether someone in this Association would not call attention to one of the great merits of chloroform. I am sure that any military surgeon would at once have seen where we were making a mistake in omitting this point. It is absolutely foolish to talk about giving ether after a big battle. You cannot carry enough ether. Again, if it is in a hot climate, for instance, in the tropics, it is extremely difficult to get a patient under ether, and when you have, as I have had, twenty-one army wagons and several ambulances filled with wounded landed on you at one time, how do you suppose it would be possible to give ether? It is very difficult even in the country when the weather is very hot to put many patients under ether. To recapitulate, you cannot carry the necessary bulk of ether in military practice, and you cannot spend the time necessary for its administration.

ARTERIOVENOUS ANASTOMOSIS IN THE TREATMENT OF GANGRENE OF THE EXTREMITIES.

By ALBERT E. HALSTEAD, M.D.,
AND
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CHICAGO.

THE application in clinical surgery of the experimentally successful procedure of reversal of the circulation in the arteries and veins has been proposed as a means of treatment of conditions which have for their underlying cause a failure of the arteries to perform their function of conveying red blood to the tissues.

Although animal experiments have shown that it is possible to transfer the circulating arterial blood to a corresponding vein, this does not prove that this experimental feat can be successfully employed in the treatment of conditions resulting from a defective blood supply which follows occlusion of the artery from disease, or destruction of the same as a result of trauma.

The great possibilities of this procedure were early recognized by clinical surgeons. Since the early experiments of François Franck, in 1881, many have attempted to produce a satisfactory arteriovenous anastomosis in animals. It remained for Carrel, in 1902, to perfect the technique of vascular experimental surgery, and to make the first satisfactory anastomoses. The failure of the early experiments was largely due to faulty technique, and it may be said that it is largely the splendid work of Carrel that has led the operating surgeon to attempt to apply in clinical

surgery the procedure which he has demonstrated as possible in animals. However, the value of arteriovenous anastomosis cannot be fixed by experimental data alone. Its place in surgery can only be determined by actual clinical experience. For this reason we have collected all of the available cases published, and, in addition, have added a number of cases, including two of our own. From an analysis of these we hope to secure data that will permit us to place this procedure in its proper relations, and determine its value as a practical surgical measure.

The indications for arteriovenous anastomosis are chiefly in cases where, as a result of occlusion of an artery, it becomes necessary to transport arterial blood by way of the veins to the capillaries. This obstruction of the circulation through a principal artery, leading to ischemia of the parts supplied with blood through that artery, results generally from some disease by which the artery gradually becomes obliterated, or from the stoppage of an artery by an embolus, or from destruction of an artery by trauma. In all of these conditions arteriovenous anastomosis has been tried, with a hope that by substituting the vein for the artery below the point of obstruction an adequate supply of red blood might be furnished, and thus prevent death of the parts below.

Experimental work on animals has played a large part in the development of a practical working technique in all vascular surgery. For this reason a brief review of the experimental work done, in perfecting the operative procedure now under consideration, seems to be essential before the clinical aspects are considered.

HISTORICAL REVIEW OF EXPERIMENTAL WORK ON ARTERIOVENOUS ANASTOMOSIS.

While experimental and clinical suture of veins dates back about as far as venesection, and while suture of arteries was already successfully practised in 1759, anastomosis of the two does not seem to have been attempted until 1881. In this

year François Franck performed an arteriovenous anastomosis of the femoral artery and vein on dogs in attempting to make an arteriovenous aneurysm. He first tried inserting the Graefe knife into the femoral vein by way of one of its collaterals, and then slipping it through the other wall of the vein and then into the artery. This procedure resulted in a profuse hemorrhage at the site of the operation, but not in the production of an aneurysm. Therefore, he next proceeded by baring both vessels of their adventitia, laying them in apposition, and closing the wound. After waiting sufficiently long for the vessels to become well adherent, he reëxposed them and passed the knife in the same way, with the result that the arterial blood flowed into the vein, which pulsated markedly, and a tracing was obtained with the sphygmograph which resembled the usual pulse tracing.

This was a matter of some scientific interest, but of no apparent practical value at that time, and was not even reported by Franck until 1896.

No further experimentation in this direction seems to have been attempted until Raymond Petit attacked the problem in 1896. In this year, among other experiments on the arteries and the veins, he twice did a latero-lateral suture of the femoral artery and vein in dogs, both of which cases ended in a fatal hemorrhage. In the second case the artery broke in two. He also demonstrated the useful fact that loose strands of catgut inserted into the lumen of the vein could become absorbed without producing clotting. His venous anastomoses were, however, more successful than his arteriovenous.

In 1898 Gluck was successful in transplanting a piece of the carotid between the two cut ends of the jugular vein, and also a piece of the jugular vein between the two cut ends of the carotid. He used a circular suture, and the vessel remained open. He used a prothesis of rubber, decalcified bone, or artery wall to reënforce his anastomosis rings.

In 1892 Vignolo also successfully performed an end-to-end anastomosis of artery and vein.

Carrel, working with Berard, in 1902, experimented with the prothesis method. He first used Payr's rings, which of late have been popularized by Lespinasse and Fisher, and also tried a prothesis of caramel, but finally discarded them both as useless. Then he experimented with end-to-end and end-to-side suture, using a technique very similar to the one he uses at present. He made only one attempt at the time of his first report to do arteriovenous anastomosis, and this resulted in death of the dog two days after the operation from hemorrhage. He was doing this work in order to make possible the transplantation of organs as a physiological experiment. In his next report, however, of the same year, he relates with Morel two successful end-to-end anastomoses of the jugular and carotid, performed twice, with Professor Soulier, on the advice of Professor Jaboulay, because the latter thought it might be useful in thrombosis of the carotid with threatening softening of the brain.

San Martin y Satrustegui, in the same year, and some time before Carrel, tried this same jugular-carotid anastomosis on three goats, but without success.

In 1903 Exner and Hoepfner both attempted arteriovenous anastomosis, but found all their attempts followed by thrombosis at the site of the anastomosis.

In 1903 Gallois and Pinatelle experimented on the cadaver with a red injecting fluid, to determine the efficiency of the valves in arteriovenous anastomosis. They found that when they injected fluid into the main vein of the extremity it returned by the other veins, but when they occluded the other veins, the fluid would no longer flow into the main vein. Therefore they said the flow was obstructed by the valves. Whether or not the peripheral veins were obstructed by thrombi in their smaller branches does not seem to have been determined. From these experiments on the cadaver Gallois and Pinatelle therefore concluded that the valves could not be forced in the living also, a conclusion which does not seem justified from their experiments.

Carrel and Guthrie, in 1905, reported a series of thirteen arteriovenous anastomoses, with only a single failure; and in a subsequent article, the following year, they reported having under observation an animal in which the jugular-carotid anastomosis had remained open for seven months. Since the publication of these later articles of Carrel and Guthrie, a very considerable number of successful anastomoses in animals have been reported by Stich, Tuffier and Frouin, Watts, Cottard and Leriche. Most of these experimental observations, however, extend over relatively short periods of time, and it would be difficult to prove in many of them that the reversed arterial blood actually reached the peripheral veins and capillaries.

Up to the present writing there have been no means proposed of breaking down the resistance of the venous valves to the backward flow of blood, except by the action of the arterial current itself. It is also still a matter of doubt how much of the reversed current reaches the periphery in these cases, and how much is short circuited, and what the individual variations are in the different cases. It is not even known for certain whether the femoral or saphenous vein, or their branches, will carry backward to the capillaries sufficient blood to maintain, unaided by the other vessels, that is, the collateral arteries, the circulation in the periphery of the limb. All these questions still remain to be determined by further experimentation.

CLINICAL RESULTS OF ARTERIOVENOUS ANASTOMOSIS.

The first operator to attempt arteriovenous anastomosis in man as a means of treating gangrene of the extremities was San Martin y Satrustegui, a Spanish surgeon, who reports two cases. The first operation was performed in 1902, in the same year as, but prior to, Carrel's successful reversion of the circulation in the carotid artery and jugular vein. In San Martin's first case a double end-to-end anastomosis of the femoral artery and vein in Scarpa's triangle was done in the hope of checking an extending gangrene that had involved the great and second

toes in a man, aged fifty-two years. The immediate result was satisfactory, but the return of pain and the extension of the gangrene called for a thigh amputation on the sixth day after the anastomosis had been made. Death from "exhaustion" followed the amputation. Obliterative endarteritis and occlusion of the veins by thrombi were found at autopsy.

In a second case, reported with the first by the same author, he was unable to do an end-to-end anastomosis because of the great thickness of the artery. A puncture was made in the artery and a corresponding one in the vein. The vessels were then united by suture. The pains ceased, but the extending gangrene called for amputation in the middle of the foot. The amputation wound healed quickly.

The third case operated upon was that of Jaboulay. This operation was performed in 1902, shortly after those of San Martin. In this case obliterative endarteritis had caused gangrene of one lower extremity, calling for amputation at the thigh. A few months later symptoms of ischemia appeared in the other leg. These symptoms increasing, together with ulceration of the foot, led Jaboulay to attempt arteriovenous anastomosis. This was accomplished by lateral union of the vessels. The immediate result appeared hopeful, although at no time was pulsation or distention of the veins noted. On the fourteenth day after the operation gangrene of the foot was manifest and extended until a line of demarcation was found at the upper third of the leg. Amputation at the thigh was done twenty-eight days after the anastomosis.

Since the report of these three cases, all of which were operated upon in 1902, there have been reported 34 cases in literature at our command.

Through a personal communication, Dr. Carl Beck, of Chicago, has given us the details of two patients operated upon by him (one a double anastomosis). These with 2 cases operated upon in our clinic at St. Luke's Hospital make in all 41 cases, with 42 arteriovenous anastomoses that have been performed for threatened or actual gangrene up to the present time.

Of the 42 operations on 41 patients reviewed in this paper, there were 40 in which the sex was noted. Of these, 28 were males and 12 females. The age was noted in 34 cases. This varied from twenty to ninety years. Classified in decimal periods, there were:

Between 20 and 30 years	3
Between 30 and 40 years	1
Between 40 and 50 years	6
Between 50 and 60 years	4
Between 60 and 70 years	13
Between 70 and 80 years	5
Between 80 and 90 years	2

In Carl Beck's first case a double operation was made for bilateral gangrene. Of the others, 11 were for "threatened" and 31 for actual gangrene.

Of these cases, the cause of the gangrene was given, or could be inferred from the pathological report, in 41. Of these, there were 33 described as arteriosclerosis; two were due to embolism; 1 to infection, and 3 to presenile endarteritis. Of the latter, the case of Lilienthal is of interest inasmuch as gangrene occurred in a young man aged twenty. At operation the popliteal artery which was to be anastomosed was found sclerosed and obliterated. Later on another anastomosis was made high up in Scarpa's triangle. Of the two other cases of this type, von Schmieden reports one in a male, aged twenty-nine, the only etiological factor evident being the too free use of tobacco. Carl Beck reports a case of this form of gangrene in a young negro (age not stated), in whom the cause of bilateral gangrene was thought to have been exposure to cold nine years previously. Previous to the operation there was no tendency to the formation of a line of demarcation. After the operation this appeared promptly on the right side, while the gangrene spread rapidly on the left. Double thigh amputation was required eventually. On the left side there was arterial spurting noted at the amputation, while on the right side parenchymatous oozing alone was seen. Examination of the amputated legs revealed obliterating endarteritis. Both amputated stumps healed kindly.

In two of von Schmieden's cases, the femoral artery at the time

of operation was found about the size of a goosequill and pulseless. No attempt was made to complete the operation. Amputation was performed. The stumps healed slowly.

Embolism was the cause of actual gangrene in two cases—those of von Schmieden and Doberauer. That of v. Schmieden occurred in the course of an endocarditis in a female, aged forty-eight years. The right foot first became cold, cyanotic, and pulseless. Gangrene developed, and an amputation of the leg was performed. Later, the same symptoms appeared in the other foot. Anastomosis of the femoral artery and vein by Carrel's method. Immediate pulsation in the vein below; although no pulsation could be felt in the foot, yet the color distinctly improved; anesthesia persisted. Two days after the anastomosis the color became darker, the anesthesia more marked. Death from cardiac insufficiency on the third day. Autopsy showed a clot below a patulous anastomotic opening. All valves of the veins seemed to have been forced. Von Schmieden's opinion is that the anastomosis was the immediate cause of death by throwing too much work on an already impaired heart.

Anastomosis of the axillary artery and vein was done by Doberauer for "threatened" gangrene due to embolism. In this case arteriotomy was twice done with the hope that by removing the obstruction the circulation might be restored. This procedure failing, anastomosis was resorted to, with success. Active pulsation of the vein below the point of anastomosis was evident for eight days. No further history is given.

Anastomosis was resorted to in three cases of traumatic gangrene of the lower extremity. Of the cases reported under this head we have one of Carl Beck, one of Imbert, and one of Torrance. In Beck's case the patient suffered from a compound comminuted fracture of both bones of the leg. Anastomosis of the proximal end of the anterior tibial artery to the cut distal end of the corresponding vein was done by Carrel's method. Within a few hours the color improved in the leg below the anastomosis. No extension of the gangrene. Death in forty-eight hours from pneumonia. No examination of the leg made.

Imbert's case was that of a sailor who received a gunshot wound of the deep femoral and popliteal arteries, and also a perforation of the popliteal vein. End-to-end anastomosis of the popliteal artery and vein after ligation of the deep femoral. Gangrene supervened, necessitating amputation at lower third of thigh.

Torrance anastomosed the anterior tibial artery to the internal saphenous vein in a case of compound comminuted fracture of the right leg. The posterior tibial artery was intact. The circulation in the foot remained adequate, although the anastomosed artery and vein became impervious and sloughed on the twelfth day. Amputation was performed four months later for disease of the bone. In a case described as gangrene due to "suppuration," Orhan anastomosed the popliteal artery and vein when the gangrene had involved the small toe alone. Warmth returned for a short time to the foot, but the next day the gangrene spread. Amputation of the leg was necessary.

Of gangrene ascribed to arteriosclerosis there are 33 cases, most of which possess no particular interest from the pathological side. In four the gangrene developed in the course of a diabetes, probably the essential cause of the arterial disease. It is reasonable to suppose that in many more of the cases there existed glycosuria, but no mention is made of it. Of the four cases in which diabetes is mentioned as a factor in the etiology, we have our own two, one of Mauclaire and one of Fritz Mueller.

Local changes indicating an immediate improvement were noted in 23 cases. The signs interpreted as favoring an increased arterial blood supply due to the reversal of the circulation are, in order of frequency:

1. Increased warmth of the affected part.
2. Improvement in color.
3. Relief from pain.
4. Improvement in sensation.
5. Filling of the superficial veins.
6. Pulsation in veins of the extremities below the site of anastomosis.

7. Return of the part threatened by gangrene, or actual seat of gangrene, to the normal.

In general, in many of the cases said to show improvement no mention is made of the specific evidences of return of the circulation.

The restoration of normal color is many times the only sign noted.

Pulsation of the vein in the extremity, which is considered by some as conclusive evidence of a restored circulation, is mentioned in 14 cases. In some it is not clear whether it is meant that the main trunk pulsated below the anastomosis in the operation wound, or that superficial or deep veins some distance below were actively pulsating.

In the case of Ballance, a woman, aged seventy-five years, operated on for senile gangrene, immediate pulsation in the femoral vein was noted. Later on in the same day the veins on the dorsum of the foot were seen to be filled with blood and to pulsate. The gangrene, which is described as reaching the dorsum of the foot, remained stationary; the discoloration of the two toes immediately disappeared. The tissues regained their normal appearance. The patient died four months after the anastomosis, during which time the gangrene did not extend.

This is the only case that we found where the circulation was so far improved by the anastomosis as to control an actually existing gangrene, and to bring about a restoration of the part, not actually gangrenous, yet presenting evidence of impending gangrene.

The value of active venous pulsation as an evidence of actual reversion of circulation in the extremity is questioned by Delbet. He maintains that it indicates only a modification of the blood pressure in the veins, and not a circulation of arterial blood through the vessel.

The experiments of Gallois and Pinatelle go to show that there exists a centrifugal blood wave in the veins. Delbet and Monod and Vanverts regard this as offering an explanation of

the venous pulsation in arteriovenous aneurysm, rather than that the arterial blood actually passes through the vein.

In one of Wieting's cases an anastomosis of the femoral vessels was made for "threatened" gangrene. Previously the opposite leg had been amputated for gangrene due to arteriosclerosis. After the anastomosis the lividity and pain disappeared. The toes and foot regained their normal color and were warm. Two months after the operation there were no pains or other signs of impending gangrene.

Regaining of warmth and return of normal color, if established, would be strong presumptive evidence of the possibility of establishing a reversion of the circulation. In the cases in which this was noted, excepting in the two mentioned (Wieting and Ballance), these favorable signs were of short duration. In our first case they were present after the operation and lasted for about one week.

REMOTE RESULTS.

In the cases reported we find:

Deaths	21	
Recoveries	20	
Deaths after primary operations, without secondary amputation		11
Deaths after amputation		9
Deaths after opening abscess		1
		21

In 7 no definite statement is made as to the immediate results.

In 4 anastomosis was not accomplished.

In two of von Schmieden's cases the pathological condition found in the artery would not permit of anastomosis being made. The femoral artery was ligated in each and the amputation of the thigh performed after the line of demarcation had formed. Both recovered.

In 2 of Mauclaire's cases the anastomosis leaked and the femoral artery was ligated in each. In both death occurred—in one from "cachexia," "in a few days," and in the other from "cardiac and pulmonary complications shortly after the operation."

Amputation of the leg or thigh followed the anastomosis in 18 cases. Of these, 9 recovered and 9 died.

Deaths directly traceable to the anastomosis operation occurred in 3 cases.

In Lilienthal's case, in thirty hours, from shock.

In one of von Schmieden's, cardiac failures due to increased work thrown upon the heart, on the second day. This was a case of embolic gangrene with endocarditis and mitral obstruction.

In Imbert's case, from exhaustion following operation, on second day.

Deaths from causes not traceable to the anastomosis occurred in 8 cases:

1. Beck's case, pneumonia, in forty-eight hours.
2. Goldenberg, erysipelas, on fifteenth day.
3. Ballance, gangrene of intestine, four months after.
4. Celesia, syncope, on twenty-seventh day.
5. Jaboulay, pulmonary embolism, on nineteenth day.
6. Jaboulay, cerebral embolism, on fifth day.
7. Halstead, diabetic coma, on fourth day.
8. Fritz Mueller, diabetic coma, on tenth day.

In the remaining cases (10) death was ascribed to the disease that called for the anastomosis, and followed secondary operations in most cases, and therefore could not be charged to the anastomosis.

It goes without saying that the probability exists that the patient's chance of recovery would have been better had amputation been the first operation and not the last resort.

Reports of autopsy findings and of the examination of the amputated leg are as follows:

The anastomotic opening is specifically mentioned in 8 cases; in 6 it was patulous; in 2 it was closed.

All of the vessels of the limb are reported closed by thrombi in 5 cases.

The femoral artery above and popliteal artery below are reported closed in 5 cases of double anastomosis.

The femoral vein alone was reported closed below the anastomosis in 5 cases.

The veins below the anastomosis were reported filled in 6 cases.

The anastomotic opening was imperfect in one case.

Short-circuiting of blood through a collateral vein was evident in one case.

Occlusion of central end of artery was found in 2 cases.

Red blood was seen to spurt from the anastomosed vein at time of the secondary operation in 2 cases.

TECHNIQUE IN FEMORAL ANASTOMOSES.

	Cases.
End-to-end	22
Femoral: Beck	2
v. Schmieden	1
Mauclaire	3
Hubbard	4
Geo. Mueller	1
Halstead	2
San Martin	1
Lilienthal	1
Tuffier	1
Lund	1
Jaboulay	2
Armour and Smith	1
	20

Lateral implantation (Wieting's method):

	Cases.
Femoral: Tietze	1
Goldenberg	1
Wieting	1
F. Mueller	2
Krueger	1
	6

Laterolateral:

	Cases.
Femoral: San Martin	1
Jaboulay	2
Tuffier	1
Abalos	1
Imbert	1
	6

Other vessels than the femoral were united in four cases.

	Cases.
Anterior tibial: Torrance	1
Carl Beck	1
	2

	Cases.
Axillary: Doberauer	1
Popliteal: Imbert	1

No mention of method in 6; Celesia, 1; Mauclaire, 2; von Schmieden, 2; Ballance, 1; Orhan, 1.

CONCLUSIONS.

1. There is experimental evidence to show that in animals the circulation through the large veins of the extremities may be reversed, and that it is possible for the normal blood pressure in the arteries to overcome the resistance of the valves of the veins.

2. Experimental and clinical evidence show that the anastomotic opening is not permanent, but that gradual obliteration by intimal overgrowth takes place in event of the failure of early occlusion by a thrombus.

3. There is not sufficient clinical evidence in the reported cases to show that the pressure of the blood in the arteries in the cases operated upon was sufficient to force the valves in the veins.

4. It is also shown by the cases reported that early occlusion of the vessels about the anastomotic opening by a thrombus was the rule, and in many the opening never at any time functionated.

5. In event of the arterial blood forcing the valves in close proximity to the anastomotic opening, it returns chiefly through the larger communicating veins and does not traverse the capillaries in many if not most instances.

6. A study of traumatic arteriovenous aneurysm shows that with a normal arterial pressure it required weeks or months

for the valves in the communicating vein to be overcome, as is evidenced by the gradual development of varicosities and the long-delayed pulsation in the veins remote from the seat of aneurysm. Under these conditions, the arterial blood supply is maintained partly through the usual collateral channels which are unobstructed. In cases of gangrene from obliterating diseases of the arteries, the collateral vessels are already occluded. In such a case immediate reversion of the circulation is imperative. This cannot be accomplished at present:

(*a*) Because of the obstruction offered by the valves.

(*b*) Because in many cases the circulating blood must also overcome the resistance offered by a thrombosed vein.

(*c*) Because the blood returns through the nearest communicating vein and does not reach the peripheral capillaries.

7. Our final conclusion is that there is but one indication for the application of arteriovenous anastomosis in surgery, *i. e.*, in traumatic destruction of a principal artery, where end-to-end union of the torn vessel is impossible. In such a case arteriovenous anastomosis might be attempted, and through it we might maintain a sufficient blood supply to preserve the integrity of the limb until an adequate collateral circulation was established.

CASES OPERATED ON BY DR. HALSTEAD.

CASE I.—Engineer, aged sixty-two years; entered St. Luke's Hospital, May 22, 1910. Fifteen years ago he was refused life insurance because of sugar in his urine. Has been on a diabetic treatment under doctor's care most of the time since then. Sugar is still present on admission. No diacetic acid or acetone.

Two years ago a corn developed on his left foot; an ulcer gradually formed at this site, and from here a slow infection went on, which necessitated amputation of his foot. A similar ulcer now developed on his right foot, and for this he entered the hospital.

May 24. Ulcer of the foot painful. Surrounding tissue red, edematous, and tender. Daily dressings with limb elevated in the interval and heat applied. No improvement.

July 8. Amputation of the right fifth toe and metatarsal under spinal anesthesia. Fifteen drops of 2 per cent. cocaine solution used. The tissue removed was nearly all necrotic. No sutures were applied. Balsam of Peru dressing. Daily irrigation with boric acid solution and dressing of balsam of Peru. Some apparent improvement for a couple of weeks. Then the gangrene began slowly to spread, and the patient began to suffer from severe pains in the foot and leg.

August 11. Arteriovenous anastomosis done by invagination of the femoral artery into the femoral vein, in the hope of producing demarcation. Incision at apex of Scarpa's triangle. An attempt was made to form a cuff on the artery, for it was too rigid; therefore, the artery was drawn into the vein by three fine Pagenstecher sutures and the vein closed over the artery by additional fine catgut sutures. When the constriction was removed from the artery, no hemorrhage occurred from the sutured vessels, but pulsation was visible in the end of the femoral vein exposed in the operation wound. The soft parts were united around the vessels with catgut and the skin with silkworm-gut and the usual silver-foil dressing applied. Patient put to bed with foot elevated and wrapped in cotton. The operation wound healed promptly by primary intention.

August 12. No pain in the foot today, but some slight tenderness around the base of the fourth toe. Color much less dusky and foot warmer than before the operation. No particular dilatation of the superficial veins noted at any time, nor any pulsation in them.

August 15. Foot is apparently improving daily; warmth and color good. No pain. But toes are still rather cool and the fourth toe has not as good a color as the others.

August 16. Metatarsal region cooler and has not so good a color as yesterday.

August 17. Metatarsal region and toes darker and colder. Some disagreeable odor at the previous amputation site.

August 18. No improvement; pains at times severe.

August 20. Slight amount of acetone in the urine; no diacetic acid.

August 22. Metatarsals appear doomed to dry gangrene. The duskiness is extending up the foot.

August 24. Cyanosis extending to side of foot and along sole. Patient seems a little irrational at times.

August 25. Sleeps a good deal; is sometimes hard to rouse.

August 26. Gritti-Stokes amputation of the thigh. The anastomosis is removed with the distal portion of the leg.

September 5. Stitches removed and dressing done. Amputation stump is healing well.

Death on September 14, five weeks after anastomosis, from diabetic coma.

The chief reason for attempting arteriovenous anastomosis in this case was that the patient had previously lost one leg from gangrene. The toes on the remaining foot were destroyed and everything pointed to a rapid spread of the gangrene to the leg. With a hope of limiting the gangrene to the part then affected, the operation was performed. There was strong evidence of an immediate improvement in the circulation of the foot. The pains, which were almost unbearable, ceased, and for five days the patient was free from discomfort. The color seemed to improve and the extremity was distinctly warmer than before the operation. Return of pain and spread of the gangrene made amputation of the thigh imperative. After the amputation no great improvement in the patient's condition was noted. Death resulted from diabetic coma on September 14, five weeks after the anastomosis was made, and two weeks after the amputation.

The leg was examined in the laboratory of Rush Medical College. The following are the findings upon dissection of the leg.

"The part submitted for pathological examination is that portion of a lower extremity of the right side situated below a point 6 cm. above the knee-joint. The specimen has been

preserved in a 10 per cent. solution of formalin. On examination it is found well-preserved and unchanged, except for the removal of the fifth toe at the metatarsophalangeal junction, and an ill-defined area about the site of removal, and including the fourth toe, which is black and hard and shrivelled.

"Dissection is begun near the upper end of the incision through an unhealed longitudinal incision, about 7.5 cm. long, over the middle of the popliteal space. From this point the vessels, both superficial and deep, are carefully dissected out, upward to the limit of the specimen, downward to a point where they become inextricably fused with the black, hardened mass already described.

"Immediately beneath the incision there is found an artificial connection between the artery and vein at a point 6 cm. from the upper limit of the specimen. The vessels are sutured end to end with silk; there is a considerable thickening of fibrous tissue over the point of anastomosis. The free peripheral end of the artery and the free central end of the vein have been ligated. All of the femoral artery present above the point of anastomosis is full of a somewhat elastic substance composed of reddish-brown and lighter colored laminæ. Just distal to the anastomosis there is a saccular aneurysm in the popliteal vein, measuring about 1.5 cm. in diameter. This extends down to the next pair of valves, about 2 cm. below the line of suture, and is full of a substance similar in all respects to that found in the artery above. With the exertion of a slight force a probe of the size of a small goose-quill can be passed from the arterial side to the venous side of the anastomosis. From the artificial connection downward it is possible to dissect free the popliteal vein for a distance of 22 cm., the upper 8 cm. of which is occluded by a mass continuous with that in the aneurysm and identical with it. The lower 14 cm. is patent, but has flakes of calcium salts deposited in its walls.

"The portion of the popliteal artery lying between the site of the anastomosis and the artery's bifurcation is 17 cm. in length and is more or less occluded by disconnected hard masses,

the largest of which do not quite fill the lumen. The anterior tibial artery is 40 cm. in length, and in its proximal 18 cm. has an average diameter of 3 mm. Beginning at a point about 1 cm. from its upper end, there is found a transparent cord-like elevation on the vessel wall, which rapidly increases in thickness until at a point 8 cm. lower down the channel has been reduced to less than 1 mm. At varying intervals beyond this the caliber of the channel is seen to increase, decrease, disappear, and recur. The texture of this obturating cord-like structure is soft and elastic above, losing its resiliency as it proceeds downward until at the points of complete occlusion it attains a cartilaginous hardness, with a suggestion of brittleness on palpation. In the softer upper part well-defined bloodvessels filled with blood are found. That portion of the vessel wall which is not hidden from view is of a corrugated and sacculated appearance, and of gristly consistency on section.

"The posterior tibial artery is 34 cm. in length and the entire vessel presents on longitudinal section an appearance similar to that described in the free portions of the anterior tibial artery. In the parts where this is most marked the vessel wall is exceedingly thin. There is no obturating formation in this vessel. The peroneal artery measures 29 cm. in length and contains friable masses which before compression filled the entire lumen. The long saphenous vein is apparently free from gross pathological change. The small saphenous vein is occluded by disconnected masses of various lengths and of the same friable consistency as those described above.

"Sections for microscopic examination are removed as follows: A piece of the posterior tibial artery is excised *in toto*, whereas segmental sections only are taken from the bulge of the aneurysmal sac and from the portion of the artery immediately above it.

"On examination, the section from the posterior tibial artery appears as a tubular structure of fibrillar texture without cellular differentiation, but showing a slight division into strata. With eosin and hematoxylin it takes a fairly even violet stain.

Irregular nodules of granular material are seen on the inner wall and intramurally.

"Sections from the wall of the aneurysmal sac show a much thickened intima, with a peculiar radiate structure, which fuses directly with the thrombus that fills the lumen, and which is permeated by cells and well-staining nuclei, giving evidence of the beginning of well-defined organization.

"In the sections taken from the artery immediately above the sac there is a thrombus undergoing more active organization, without any noticeable changes in the vessel wall."

CASE II.—Mrs. K. A., aged sixty-four years; German; entered hospital September 23, 1910. States that right great toe has been discolored and ulcerated for a week. The foot was blanched and no pulsation could be felt in any vessel below the knee. Four and three-tenths per cent. sugar in urine on admission. Tests for acetone and diacetic acid positive. Denies previous illness or previous knowledge of diabetes.

September 25. Gangrene seems to be spreading upward. Amputation of the toe refused. Daily bismuth powder dressing.

September 27. End-to-end anastomosis by intubation of femoral artery and vein near the apex of Scarpa's triangle. No hemorrhage occurred at the site of anastomosis when the constricting tapes were removed from the vessels. That part of the vein visible in the operation wound at once dilated and began to pulsate. The soft parts were closed around the anastomosis by catgut and the skin with silkworm-gut and silver foil in the usual way.

The patient went rapidly into diabetic coma, and died three days after the operation.

In this case there existed a gangrenous ulcer that refused to heal. Amputation was refused. Anastomosis was performed, with the hope that the pain would be relieved and the spread of the gangrene controlled. After the operation, which was difficult because of the small size of the vein and the extreme hardness and thickening of the arterial wall, pulsation as far as the lower end of the operation wound was observed in the

vein. No change in color or improvement in the general appearance of the foot were noted. This remained cold and livid. No extension of the gangrene. Death occurred in diabetic coma on the fourth day succeeding the operation. No autopsy.

CASES OF DR. CARL BECK.

CASE I.—Chicago, December, 1910. Young colored man. Gangrene of both feet several inches above the ankle, cause unknown. Patient said feet had been numb ever since freezing them nine years previously. The gangrene did not show a tendency to become demarcated, and therefore an end-to-end anastomosis of the femoral artery and vein was done by Carrel's method. Shortly afterward (exact time not given) the line of demarcation formed on the right side, and the dead tissues separated piece by piece up to the bone. The gangrene having progressed in the left leg, it was decided to do at the same time a double amputation of the thighs. At the time of the operation in the right leg there was no spurting of bloodvessels in the cut tissue, but parenchymatous oozing of bright red blood, apparently "showing this leg relatively well supplied with arterial blood through the veins." On the left side there was quite a little arterial spurting. The vessels in both legs showed endarteritis in the amputated parts, and both sides healed perfectly after the operation. No further examination of the arteries or subsequent history of the case mentioned. Nothing said as to dilatation of the veins, change in color of the parts, or pulsation of the veins.

CASE II.—Compound comminuted fracture of the leg below the knee, between the middle and lower third of tibia. No pulsation in the arteries of the foot. Skin blue and cold. The anterior tibial artery was cut down upon and the upper end found and allowed to spurt, and the distal end sought for, but not found. Therefore, an end-to-end anastomosis was made between the proximal portion of the artery and the distal

portion of one of the large veins in the neighborhood. Shortly afterward the distal part of the crushed leg began to acquire a brighter color and more warmth, and remained so without any further signs of gangrene for forty-eight hours, at the end of which time the man died of a pneumonia. The anastomosis in this case was done by Carrel's method. Nothing said as to pulsation of the veins or subsequent examination of the anastomosis or vessels of the leg.

PREVIOUSLY REPORTED CASES.

San Martin y Satrustegui ("Cirurgia del aparato circulatorio," *Discours prononcé à la séance inaugurale de l'Académie royale de Madrid*, année 1902): Man, aged fifty-two years, farmer. Gangrene of a few months' standing in the great toe and part of the second, and about to attack the metatarsal. Double end-to-end anastomosis done. Immediate result satisfactory; then on the sixth day pains reappeared, with fever. Amputation of the leg at the site of election. Patient died of exhaustion after an amputation of the thigh (subsequent). Postmortem examination: The posterior tibial artery was obliterated by a marked proliferation of the intima. The adventitia was thickened and its vessels obliterated. The anterior tibial artery and the vein were apparently normal.

San Martin y Satrustegui (same reference as above): Man, aged seventy-six years; no syphilis or alcoholism. Followed application of a too tight bandage. Gangrene continued to develop in spite of disarticulation of the toes. Laterolateral anastomosis done. Artery was too thick to do an end-to-end anastomosis and was hard as a rock, so that two bistouries were spoiled on it. Finally, a puncture was made in the side, and the vein was sutured to this. A Symes amputation in addition; pains disappeared and wound healed. No report on the ultimate result.

Jaboulay ("Un cas d'anastomose artérioveineuse longitudinale pour artérite oblitérante," *Rev. de Chir.*, 1903, xxvii, 236; and

in A. Lecercle, "Anastomoses artérioveineuses, Contrib. à l'Etude de la chirurgie des vaisseaux," *Thèse de Lyon*, 1902–1903, No. 79, obs. III): A man, aged forty-seven years, alcoholic. Amputation of the right thigh (1902) for dry gangrene from arteritis. Arteriovenous anastomosis done two months later for similar gangrene in left leg. Laterolateral operation was done in the triangle of Scarpa. No pulsation in the veins followed, nor other signs of success. The gangrene progressed and an amputation of the thigh was performed at the end of a month. The large vessels were obliterated at the site of the amputation. Patient died on the fifth day, probably from a cerebral embolus. Examination of the amputated leg showed all the large venous trunks filled with relatively fresh clots. The popliteal artery was partly opened, but at the point of division was entirely obliterated.

J. C. Hubbard ("Arteriovenous Anastomosis," *Boston Medical and Surgical Journal*, 1906, clv, 647; Annals of Surgery, 1906, xliv, 559): Man, aged eighty years. Senile gangrene of part of the right foot. Invagination of the femoral artery into the femoral vein above the point of origin of the femoralis profunda, slight pulsation following the operation in the femoral vein just below the anastomosis. No change in the limb after operation. Gangrene extended to all the foot and then became demarcated. A month later amputation of the leg at the site of election. The anterior and posterior tibial arteries poured out red arterial blood. Patient well one year later.

Doberauer ("Demonstration eines Falles von operierter Embolie der Arteria axillaris," Wissensch. Gesell. deut. Aertze in Boehmen, July 3, 1907; *Prager med. Wochens.*, 1907, xxxii, 437): Woman. Embolism of the humeral artery. Threatened gangrene. Artery twice opened and a clot removed. Thrombus formed the third time and gangrene progressed. Two days after the last arteriotomy the axillary artery and vein were anastomosed. Active pulsation in the vein below the site of anastomosis, which continued for eight days. Nothing said as to further outcome of treatment.

J. C. Hubbard ("Arteriovenous Anastomosis," *Boston Medical and Surgical Journal*, 1907, clvii, 185). Woman, aged sixty-six years. Senile gangrene of the foot and part of the leg, due to atheroma. End-to-end anastomosis of artery and vein (femoral) in Scarpa's triangle, below the origin of the femoralis profunda. Artery was calcified and friable, so that the threads tore through the wall, but after completion of the operation the vein showed pulsation. No improvement in the limb after the operation. Ten days later amputation was done above the knee. Examination of the amputated limb showed the artery filled by a fresh clot.

Lilienthal ("End-to-end Arteriovenous Angeiorrhaphy," *Annals of Surgery*, 1907, xlv, 2): Man, aged twenty years. Gangrene of the feet from arteritis. An attempt to anastomose popliteal artery and vein was given up because the artery was found completely obliterated. Four days later end-to-end anastomosis of the artery and vein was done above the entrance of the saphenous vein. The anastomosis was done at this level because only the upper part of the femoral artery showed pulsation. The operation lasted fifty minutes and was followed by considerable shock. The patient died thirty-one hours later without there being any signs of improvement in the affected limb. Examination of the anastomosis showed that the union was good, but there was a fresh clot in the vein. Lilienthal thinks that any operation on this weakened patient would probably have produced death.

Torrance ("Arteriovenous Anastomosis, with Report of a Case," *Annals of Surgery*, 1907, xlvi, 333): Man, aged forty years. Complicated fracture of the right leg. Posterior tibial artery ruptured. Much shock. The anterior tibial artery was implanted into the saphenous vein. Suture of the soft parts. Pulsation continued in the artery for one day and then stopped. A clot probably formed. The foot healed. Four months later the leg was amputated, at the patient's desire, for "disease of the bone." Examination of the amputated part is said to have given no evidence as to how the circulation reëstablished itself.

Tuffier (*Bull. et Mém. de la Soc. de Chir.*, 1907, xxxiii, 417): Man, aged fifty-six years; alcoholic and syphilitic. Typhoid fever at twenty years. Gangrene of three months' standing in the foot. Femoral vessels united side-to-side at the apex of the triangle of Scarpa. Vein promptly dilated and pulsated. Eight days later the foot was no better. The patient died eleven days later. Autopsy: Gangrene extended to the knee; femoral artery open; vein obstructed below the anastomosis by an adherent clot.

Tuffier (cited by E. Cottard, "Anastomoses et greffes vasculaires," *Thèse de Paris*, 1907–1908, No. 373, obs. viii, page 63): Man, aged fifty years. No syphilis; moderate alcoholism. No sugar or albumin in the urine. Violent pains in the foot and beginning gangrene. End-to-end anastomosis done in the middle of the thigh. Distal end of the artery and proximal end of the vein tied. The following day there was pulsation in the vein below the anastomosis and along the course of the internal saphenous vein. These were less marked on the following day and then disappeared. Probably slight infection at the site of anastomosis. The pains disappeared, but the gangrene remained the same. Patient left hospital in a few days. No further report.

Ballance ("Arteriovenous Anastomosis for Senile Gangrene," *Lancet*, 1908, i, 1412): Woman, aged seventy-five years. Senile gangrene of the toes of the right foot, beginning to extend to the dorsum of the foot; severe pains. Arteriovenous anastomosis at the level of Hunter's canal. Pulsation in the internal saphenous vein and in the veins on the dorsum of the foot appeared on the evening of the operation. The foot became warm and the pains ceased. The discoloration of two of the toes disappeared. The gangrene made no progress in the following months, and demarcation in the already affected toes occurred. Death five months after the operation from gangrene of the intestine.

J. C. Hubbard ("Arteriovenous Anastomosis for Gangrene," *Annals of Surgery*, 1908, xlviii, 897): Woman, aged eighty-four years. Right foot amputated for senile gangrene. A few months later the left foot showed similar change. End-to-end anasto-

mosis below the femoralis profunda. Artery shows no atheroma, but is somewhat thickened. After the operation the leg became warmer; the spread of the gangrene stopped, but a month later it began to spread again, and two months after the operation the patient died. At the autopsy there was atheroma of the femoral artery and its lumen was much narrowed. There was a thrombus obliterating the femoral vein and its branches. The anastomosis was completely obliterated.

F. B. Lund ("A Case of Arteriovenous Anastomosis for Obliterative Endarteritis," *Boston Medical and Surgical Journal*, 1908, lix, 683): Man, aged thirty-two years. Threatened gangrene of the left foot. End-to-end anastomosis of the femoral artery and vein. The superficial veins of the foot became dilated and pulsated. Gangrene of the big toe took place. Patient refused amputation of the leg, and so the big toe and its metatarsal were amputated, but the flaps underwent gangrene, and therefore a little later the leg was amputated.

Wieting ("Die angiosklerotische Gangrän und ihre operative Behandlung durch arteriovenöse Intubation," *Deuts. med. Wochens.*, 1908, xxxix, 1217): Man, aged forty years. Amputation below and then above the right knee for gangrene. A few months later severe pains set in in the left leg, with coldness and lividity. Arteriovenous anastomosis by lateral implantation of the artery into the vein was performed at the apex of Scarpa's triangle. The toes and foot became warm and pink, and the pains disappeared. Two months after the operation there were no further pains nor any signs of gangrene. The operation wound healed perfectly. A complete success.

Orhan (quoted by Wieting, reference as above, p. 1200): Suppurating gangrene of the small toe. Anastomosis of the popliteal artery and vein. Warmth returned at once to the foot, but on the next day the foot was as bad as ever and the gangrene began to spread. Amputation of the leg performed. Extensive suppuration along the fascial planes. No bleeding from either arteries or veins.

Jaboulay (cited by P. Charnois, "Du Traitement Chirurgical

des Gangrenes d'Origine Artérielle," *Thèse de Lyon*, 1908–09, No. 85, obs. v, p. 21, and also by Monod and Vanverts, "L'anastomose arterioveineuse," *Arch. gén. de Chir.*, 1910, vi, 455): Man, aged forty-three years. Intermittent claudication in the left foot. Toes cool and blue. Then dry gangrene of the toes, which began to spread. Arteriovenous anastomosis in September, 1908, with Carrel as an assistant. End-to-end anastomosis between the femoral artery and vein at the middle of the thigh. Ligature of the peripheral end of the artery and of the central end of the vein. After the anastomosis was completed the blood penetrated the vein and distended it to double its previous diameter. Operation wound healed. The gangrene seemed to demarcate somewhat, but otherwise there was no improvement. On account of the severe pains and the secondary infection of the gangrenous parts, amputation was done in the inferior third of the leg. The large arteries did not bleed, but some of the smaller muscular vessels did. The internal saphenous was thrombosed. The stump healed well and the pains disappeared. Three weeks after the operation the patient died suddenly of a large lung embolus. Examination of the limb showed that the large part of the arterial blood had been short-circuited by a collateral of the femoral vein a short distance below the site of anastomosis, so that the main arterial current did not pass to the extremity of the limb. There was a thrombosis in the femoral vein, which extended to the iliac. It was part of this clot which detached and caused death. There was also a large recent clot at the site of anastomosis. It was by the collateral mentioned above that the thrombosis spread from the site of the anastomosis to the central end of the femoral vein, thus causing death.

Abalos ("Sobre un caso de anastomosis arteriovenosa por gangrena del pie de origen ateromatoso. Arteria femoral y vena safena," *Argentina Med.*, 1909, vii, III; et Comm. ecrite, quoted by Monod and Vanverts, reference as above, p. 457): Man, aged sixty-two years. Short time previously amputation of the thigh for gangrene of the left foot; beginning gangrene of the right foot. Laterolateral anastomosis of the femoral artery

and saphenous vein at the apex of Scarpa's triangle. Immediate pulsation of the saphenous vein. Improvement for ten days; then gangrene began to spread again. On the twentieth day after the anastomosis amputation at the upper third of the thigh. Previous to this the saphenous pulsation had disappeared, as well as pulsation of the femoral artery. Two months later the patient was still living and well. Examination of the amputated leg: Femoral artery and saphenous vein were occluded by extensive thrombi.

J. C. Hubbard ("Report of a Case of Arteriovenous Anastomosis for Senile Gangrene," *Boston Medical and Surgical Journal*, 1909, clxi, 513): Man, aged seventy-seven years. Threatening gangrene of right foot, with severe pains. No dorsalis pedis pulse; no posterior tibial. No albuminuria or glycosuria. End-to-end anastomosis two inches below the origin of the profunda. Venous pulsation began immediately. Immediate improvement in the color of the foot. A week later patient was up and about. The pains were nearly gone. Three weeks later gangrene started again to spread. Five weeks after the operation amputation of the thigh at the lower third. At the operation red arterial blood issued from the vein. The diameter of the jet was such as to lead one to believe there was no diminution of the lumen.

Imbert (quoted by J. Fiolle, "Anastomose artérioveineuse dans un cas de gangrène sénile," *Marseille Méd.*, 1909, xlvi, 372): Man. Arteriosclerotic gangrene of the foot following toe amputation for gangrene. No sugar or albumin in urine. Laterolateral anastomosis of femoral artery to saphenous vein. "Immediate result excellent, but death two days later of *cachexia*." The vein dilated immediately after the operation, but did not pulsate. Postmortem: Anastomosis open, though small. Artery very sclerotic.

L. Imbert and J. Fiolle, "Trois observations de sutures vasculaires," *Marseille Médical*, 1909, xlvi, 417, obs. i: Man, aged twenty-five years; sailor; syphilitic. Bullet wound of the thigh penetrating femoral artery, and also popliteal artery and

vein. Ligation of femoral and end-to-end anastomosis of popliteal artery and vein. Pulsation in the internal saphenous the same evening, but gangrene occurred and the leg was amputated in the lower third of the thigh. Examination of the limb: Artery and vein are very incompletely united. Lumen of the artery is obliterated by adherent clots.

D. J. Armour and E. A. Smith, ("A Case of Arteriovenous Anastomosis for Gangrene," *Lancet*, 1909, ii, 919): Man, aged sixty-nine years. Arteriosclerosis marked. Threatened gangrene of the foot and leg. Double end-to-end anastomosis of the femoral vessels. Saphenous vein ligated "to prevent short circuit." No improvement after the operation. On the fourth day, line of demarcation appeared at upper third of the leg. No popliteal pulse. Two weeks after the operation amputation above the knee. It was found that the vein had remained permeable, while the artery was obstructed by a clot. At the level of the flap the vein pulsated like an artery and was tied. The vessels were cut 8 cm. below the site of anastomosis. Recovery. Examination of the amputated leg showed thrombosis of nearly all the veins.

A. F. Celesia ("Anastomosis arteriovenosa lateral (arteria y vena femoral) en un caso de gangrena del pie," *Rev. de la Soc. méd.*, Argentina, 1909, xvii, 574): Woman, aged fifty-two years. Toes of right foot amputated for gangrene, which later began to spread to the foot. Dorsalis pedis and popliteal pulse absent. Generalized arteriosclerosis. Enlarged spleen. Suture of femoral artery to femoral vein, with ligation of the internal saphenous, which was made difficult by great rigidity of the artery. The vein pulsated at once. On the seventh day slight infection at the operation site, which promptly healed, however. Three weeks after the operation the affected leg seemed in as good condition as the well one; but on the next day an abscess in the thigh was opened, and during the operation the patient died of syncope. Autopsy: No cause for death found. The femoral vein is open below the anastomosis and slightly dilated above the anastomosis. It contained

a few non-adherent clots. The artery was open above the anastomosis and below it it was filled with a very adherent clot, which extended into the popliteal.

Tietze ("Zwei Falle von Wietingscher Operation, Intubation der Arteria femoralis in die Vena femoralis bei beginnender Gangrän," Med. Sekt. d. Schlesischen Ges. für Vaterländ. Kultur, December 17, 1909; *Allgemeine Medizinische Central-Zeitung*, 1910, lxxix, 57): Woman, aged sixty-nine years. Arteriosclerotic gangrene of the foot and lower part of the leg. No diabetes. Terminolateral anastomosis of femoral artery and vein, but the blood did not seem to flow into the vein. Gangrene continued to spread after the operation. Death from cachexia on the nineteenth day. Autopsy: The central end of the artery was occluded by a clot.

Case II.—This case was operated by Tietze's assistant, Dr. Goldenberg. Patient, man, aged sixty-four years, with arteriosclerotic gangrene of the right foot. The clinical symptoms were similar to those in the first case. The operation was done by Wieting's technique, and was successful in so far as pulsation appeared in the right popliteal artery, which was absent previously. The patient also said that he experienced "a feeling of life" in the affected leg. The leg also became warmed and the sensibility improved. The gangrene stopped and demarcation occurred. On the fifteenth day after the operation erysipelas set in in the affected leg and caused the death of the patient.

Postmortem: The point of the anastomosis was surrounded by a very considerable layer of connective tissue. The lumen was open, but partly plugged with clot. The artery was so markedly changed that there was only a slight chance of success in any case. Tietze thinks that the most important thing in the operation is the selection of the proper cases for it.

Jaboulay ("Obs. communiquée par Rivière," quoted by Monod and Vanverts, reference as above, p. 463): Man, aged sixty-seven years. Beginning arteriosclerotic gangrene of the foot following slight injury with a nail scissors. Marked cardiac arhythmia. Chronic bronchitis, with congestion of the bases

of the lungs. No sugar or albumin in the urine. End-to-end anastomosis of femoral artery and vein at the middle of the thigh. Slight local improvement in foot following the operation but gangrene began to spread again five days after the operation. Seven days after the operation the whole leg was cyanotic and covered with bullæ. Fever of 40° C. Amputation of the thigh seven days after the previous operation. A large clot filled the femoral vein. Death four days later from pulmonary congestion and cardiac insufficiency.

Krueger ("Klinische Beiträge zur Gefasschirurgie," *Arch. f. klin. Chir.*, 1910, xci, 577): Woman, aged forty-eight years. Complains of paresthesia in the right foot for one year; color became black recently. No syphilis or diabetes. Demarcation has already occurred. Pulse absent in the dorsalis pedis and popliteal arteries. Operation, August 27, 1909. Spinal anesthesia, with novocaine. No constrictor used. The exact Wieting technique was used and the anastomosis done below the profunda. Peripheral arterial and central venous stumps tied. Large collateral veins in the vicinity were also ligated. About eight linen sutures were used. Before the operation Moskowicz's experiment gave a reactive hyperemia to a point just below the knee. After the operation there was no special change in the foot. The vein was intensely dilated below the anastomosis, but there was no pulsation. Krueger thought that clotting had occurred, and therefore opened the vein by longitudinal incision; but only fluid blood escaped, and this of a mixed arterial and venous character. There was slight oozing from one suture opening. Usual closure of the wound, in two stages. A few hours later the foot is markedly cyanotic; after raising it for a time, marked anemia again appeared, for which again the foot was laid down.

August 28. Patient complains of severe pain. Tips of the second to fourth toes bluish; foot cold; leg warm to the ankle.

August 29. The severe pains made morphine necessary. Blotched appearance to dorsum of foot. The gangrene of the big toe is progressing.

September 6. Pains have continued severe to date. The gangrene had reached the middle of the metatarsus; dorsum of foot copper-colored. The veins of the leg are dilated up to the knee, but do not pulsate, and are accompanied with red streaks. Operation wound has healed normally, but shows some infiltrate in the depth. No pulse below the femoral.

Operation: Pirogoff amputation of the foot. The dorsalis pedis artery is completely thrombosed; the posterior tibial is open, but does not bleed. Neither the veins nor the sawed bone bleed much. Wound closed without suture; sterile bandage. Dissection of the dorsal artery shows it completely closed to the periphery.

September 14. Marked redness and swelling of the leg up to the knee. Wound borders are gangrenous.

Operation: Amputation of the leg by Gritti's method. Preparation of the popliteal artery and vein shows them both closed by old thrombi, as likewise are all the arteries and veins of the leg, with the exception of a few superficial veins and a few deep veins. No further history.

Mueller ("Die Resultate der bisher ausgeführten arteriovenösen anastomosierungen bei angiosklerotischer Gangran mit besonderer Berucksichtigung der Wietingschen Operation," *Inaugural Dissert.*, Berlin, 1910, published by E. Ebering): Man, aged sixty-three years, diabetes for eight years; four times has had slight beginning gangrene of the toes, which healed spontaneously. In January, 1910, a small ulcer appeared on the fourth toe of the left foot. Gradually the whole toe became black. On entrance, demarcation already occurred, but there was some redness around the gangrenous area, especially on the plantar side, and not a little tenderness, which extended about to the middle of the sole. Inguinal glands not tender. Urine contains 3 per cent. sugar. For some days he was treated according to Bier's technique, with hot air baths and warm applications, but without any improvement. The left second and third toes and also the great toe have become somewhat bluish. Pains remained severe in foot. No pulse in the dorsalis pedis or posterior tibial, but strong in

the femoral. Since the gangrene seems to be spreading somewhat and since the line of demarcation has not definitely formed, operation was undertaken by Wieting's technique, on May 10, 1910. Lumbar anesthesia; femoral artery invaginated laterally into the femoral vein. Wound closed in layers. The same evening the whole leg is warm; the pains are much less; there is a feeling of numbness in the foot; there is no difference in color or temperature between the two legs.

May 11. Left leg warm; the gangrene seems to be becoming demarcated. The inflammatory reaction around it has diminished. No pains, but a feeling of weight in the leg. No pulsation or dilatation of the veins mentioned. Arterial pulse still absent in posterior tibial, and dorsalis pedis.

May 13. Demarcation still better; no pains. Five grams of sodium bicarbonate daily. On the 16th, some necrosis of the borders of the operation wound. The wound seems to have opened up somewhat in the depths on the 18th. Eructations marked. Patient very restless. Appearance of the leg good.

May 19. Vomiting. Patient is somewhat stuporous and looks bad. On the 20th, death in coma.

Autopsy. Operation wound gaping and necrotic, but the vessels are not exposed. The anastomosis site is easily recognized and is well united. An attempt was made to inject fluid unguentum cinereum with a syringe into the artery. The artery dilated under strong pressure up to the anastomosis site; then the vessels were taken out *in toto*. The lumen of the profunda is as large as that of the femoral. When the vessels were opened they were found filled with postmortem clots. At the anastomosis site the lumen was distinctly narrowed. Here the thrombus was somewhat adherent to the wall. The venous valves were stuffed full of hard thrombi, which may well have completely closed the lumen. The posterior tibial vein is freely opened. There are no thrombi on the valves here.

Case II.—Man, age not given. Smokes 120 cigarettes daily. Syphilis denied. In 1908 pains appeared in the left foot, which became easily tired. Since that time patient has

often noticed that left foot was cooler than the right. Various medicinal and bath treatments tried, without avail; also electricity. When patient came into hospital, the pains were so severe as to require control by morphine. Status: Well nourished. Left great toe inflamed and very painful. Nails of the large and small toes are absent. Necrotic ulcer on the ball of the great toe. Slight hypesthesia of the right great toe and outer border of the foot. Some small ulcers between the toes. The left foot is cold and shiny, with some bluish-red discoloration. No albumin or sugar. The pulse in the right femoral is stronger than in the left, but below normal at that. Pulse absent in the posterior tibial and dorsalis pedis on both sides. The left leg is cooler than the right. Operation, April 7, 1910: Spinal anesthesia. Wieting technique used. The femoral artery and vein exposed just below Poupart's. The artery pulsates. The vasa vasorum are markedly injected. Marked arteriosclerosis. Femoral vein not sclerotic. No hemorrhage from the sutures. Slight pulsation in the vein. Closure in layers. Leg not elevated. Evening of the same day: No change in the leg, which is warm up to the knee, but cold and numb below it.

April 28. Leg warm up to three fingers' breadth above the malleoli, and seems warmer than the right. The foot is slightly reddened. There has been no pain since the operation. Foot and toes can be moved. Sensation is rather slight in foot. Two thermometers tied on with cotton and bandages to both legs show, after being an hour and a half in position, 35.8° C., right; and 35.2° C., left.

April 29. Feet warm and red. No pains.

April 30. A few pains in the small and large toes. Legs warm. Thermometer readings: 36.4° C., right; 35.6° C., left.

May 2. More pains in the right foot; no pains in the left. The ulcers on the small and large toes are getting smaller. Patient tried to move about most every day. No pulsations visible anywhere in the legs.

May 5. More pains in the left foot, especially in the small and large toes, particularly at nights. Operation wound has healed per primam. Daily hot air treatment of the left foot and leg.

May 9. Condition of the leg good. Hot air treatment continued.

May 14. More pains at nights; two morphine injections necessary.

On the 15th the left great toe is somewhat redder; skin is shiny. On the 23d, ulcerations on large and small toes have become somewhat larger. The bluish color of the great toe has extended to the foot, and the pains are getting bad again.

June 10. Pirogoff amputation. Primary healing.

June 16. Cyanosis of the whole heel. Wound opened on one side.

June 26. Gangrene is spreading. Severe pains in foot and heel.

June 30. Amputation of the leg in the upper third. (No further history.)

Jaboulay (cited by Monod and Vanverts, reference as above, p. 463): Man, aged sixty-six years. Gangrene of the right foot. Some atheroma. No sugar or albumin. Slight congestion at the bases of the lungs. Anastomosis by Jaboulay's method in the middle of the thigh. Pains slightly diminished after the operation, but the gangrene began to extend again three days later. Five days after the operation amputation of the thigh above the site of anastomosis. The anastomosis was found permeable, but the vein was completely obliterated below. Part of one flap sloughed, thereby necessitating reamputation of the bone a month later. Otherwise the patient made an uneventful recovery.

Case I.—Von Schmieden (*Berl. klin. Woch.*, 1910, No. 13, pp. 571 to 573): Galician Jew, aged twenty-nine years: Presenile gangrene from overuse of tobacco. Left leg amputated four years ago because of similar gangrene. For the last three months

pain, coldness, paresthesia and numbness in the right foot. He can use the foot only with great difficulty. Sleep is greatly disturbed because of pain. Popliteal pulse can barely be felt. No albumin or sugar in the urine. All reflexes much increased. Some diminution in sensation in the lower leg and foot. The gangrene gradually increased in spite of medical treatment, and so Wieting's operation was tried to save the leg. Operation, November 30, 1908. The femoral artery was found pulseless, hard, and about as thick as a quill. There were many newly formed (?), small, bleeding vessels around it. No attempt at anastomosis was made, but wound was immediately closed.

Amputation was done as soon as the line of demarcation formed. The stump healed slowly. Patient left the hospital on March 2, 1909; no further history.

Case II.—A man, aged sixty-one years. Hard smoker and drinker. Beginning dry gangrene of the right small and large toes. Varicose veins marked. Much eczema of the legs and some healed varicose ulcers. Operation, January 21, 1909. The femoral artery was found pulseless and intensely sclerosed. There were many small bleeding vessels around it (old inflammation ?). Therefore, no attempt at anastomosis was made. The operation wound healed primarily. No change in the condition of the foot.

February 17. The dead toes have undergone spontaneous amputation. The condition of the patient remains good while in bed, but becomes much worse when he moves about.

March 10. Went home. No further history.

Case III.—Woman, aged forty-eight years. In 1910 amputation of the right foot was done for embolic gangrene, due to heart disease. No diabetes.

January 4, 1909. Beginning embolic gangrene of the left foot, which is cold and blue. No pulse can be felt in the whole leg. No sensation in the foot. Heart: Mitral systolic murmur and thrill. Operation, February 4, 1909. Femoral artery and vein sewed together by Carrel's method (end-to-end) just below the origin of the profunda, the vessels being first freed from their

adventitia. After removing the clamps from the vessel, the anastomosis is free from any leaking, and there is a vigorous stream of blood pulsating into the vein. No pulsation in the veins of the foot is visible after the operation, but the color of the foot is distinctly lighter. The same afternoon the color of the foot is normal, but cool. Cutaneous anesthesia is still present in the foot. Toward evening the color of the foot has become somewhat darker, but promptly improved with massage.

February 5. In the morning the leg is normal in color and warm, but the heart action weak. The patient died at eleven o'clock A.M., of heart insufficiency.

Autopsy. Severe mitral and aortic endocarditis was the cause of the gangrene. There was an old organized thrombus of the posterior tibial artery near the origin of the anterior tibial. The anastomosis was open and at only one small spot in the vein was the contained clot at all apparent, so that it could be irrigated away with water. All the valves seemed to have been forced at once. Schmieden thinks that the operation was very good for the leg, but threw too much of a load on the heart.

CASE I.—M. Mauclaire ("Quatre essais d'anast. art. ven.," *Arch. Gén. de Chir.*, Paris, 1910, vi, 815 to 826): Woman, aged sixty-three years. Senile gangrene of the whole right foot of three months' standing. Complete mummification of the foot. No discoloration or edema of the leg above the line of demarcation. No pulsation in the popliteal artery. Pulsation present in the femoral artery in the upper part of Scarpa's triangle. Tried Moskowicz's test, which consists in putting an elastic bandage around the whole extremity for five to ten minutes. When the bandage is removed, the limb becomes very red down to the area in which the circulation is inadequate, which in turn is very pale. The site of the arterial thrombus and its extent can then be estimated from the known anatomical distribution of the vessels.

In this case the whole leg remained pale. The experiment was repeated, with the same result; therefore, the thrombus was high up in the femoral artery.

Operation. Done near the apex of Scarpa's triangle. A high-grade atheroma of the femoral artery was found. End-to-end anastomosis (by intubation?) was done, the vein being cut obliquely across. Eight sutures were used, linen No. 500. Blood at once entered the vein, as could be seen from its dilatation and pulsation in the 7 or 8 centimeters exposed in the wound. No local change after the operation. Eight days later amputation of the leg in the upper third. At the operation very little blood ran out of the anterior and posterior tibial arteries. No arterial blood came from the vein. Gangrene of the flap occurred, and eight days later amputation of the thigh was performed. The same condition was found in the femoral vessels as in the tibia. Patient died seven days later of "cachexia."

Autopsy. The artery was thrombosed down to the place of suture. The vein was opened. The anastomosis was without fault.

Case II.—Male, aged seventy-two years. Pains in left foot for three months. Gangrene of the foot to the malleoli for three weeks. It is spreading to the middle of the leg. Pulsation present in the femoral artery. Moskowicz's test not used for fear of causing the thrombosis to extend. Arteriosclerosis marked. Slight albumin in the urine. Diabetes a short time previously. Same operation was done as in the preceding case. No pulsation in the femoral artery. The artery was opened and found filled with blood. Tried to pull it out by inserting a grooved director as far as the internal iliac, but was not completely successful. End-to-end anastomosis was performed, however, seven sutures being used. Death nine days later from "exhaustion." Autopsy showed that the anastomosis evidently had not functionated.

Case III.—Woman, aged sixty years. Senile gangrene of the whole foot of several weeks' duration and gradually spreading to the leg. Edema of the whole leg up to the point where arterial pulsation could be felt. Good pulsation of the arteries on the other leg. Aortic regurgitation present. Slight albuminuria. Operation, in spinal anesthesia, with stovaine. The femoral

artery pulsated well; in fact, almost too well to make the anastomosis easy to perform. There was a great flow of blood, and some escaped at the operation site. Mauclaire was afraid that the arterial sutures would not hold, and therefore he tried the femoral artery. The patient died a few days later of "progressive cachexia." No autopsy report.

Case IV.—Female, aged sixty-six years. Violent pains in toes and fingers for six months. Gangrene of the left great toe for two months. Gangrene of the right index finger. All the extremities are cyanotic. Pulsation present in both posterior tibials and dorsalis pedis arteries. The radials very arteriosclerotic. The blood pressure is 230 millimeters. Aortic regurgitation present. (Mixed senile gangrene and Raynaud's disease.) Operation: End-to-end anastomosis (by invagination ?). Femoral artery very sclerotic, but pulsated very well. Blood leaked at the anastomosis site when the emporary vessel ligatures were removed, so that Mauclaire thought it wisest, in view of the high blood pressure and water-hammer pulse, to ligate the femoral artery as in the previous case. The gangrene progressed rapidly in the following days, and amputation of the thigh was performed. Death followed shortly after, being due to "des accidents cardiopulmonaires." No autopsy report.

George P. Mueller's case ("The Treatment of Gangrene of the Foot by Arteriovenous Anastomosis," *Annals of Surgery*, February, 1910, li, No. 2, p. 246): Operation: End-to-end anastomosis by Carrel's method of femoral artery and vein at apex of Scarpa's triangle and below origin of profunda. A complete reversal was not attempted. The artery was moderately sclerosed. After the operation the vein pulsated actively below the anastomosis. The leg and foot became warm and red. No visible pulsation of the superficial veins. In forty-eight hours the foot was cold to the ankle and the leg warm. On the third day a line of demarcation occurred at the tibiotarsal joint. Amputation at the middle third of the leg was advised, but refused. There was considerable absorption of toxins. Six weeks after the operation amputation was done four inches

below the knee while the patient was in delirium. The posterior tibial and peroneal veins at this time showed feeble but distinct spurts of blood. There were many unusual sharp oozers. Anterior tibial did not bleed. All the arteries and the external saphenous vein were thrombosed. The internal saphenous vein was opened.

There was much suppuration in the flap after operation. Death occurred a little over two weeks later from exhaustion, that being nine weeks after the anastomosis. Neither autopsy nor examination of the operation site was permitted.

[Since the above article was written H. Coenen, of Breslau, read an article in the *Deutsche Gesellschaft f. Chirurgie*, and in the discussion a number of new cases were brought out. Professor Wieting, in the *Deutsche Zeitschrift f. Chirurgie* for July, 1911, has published 4 new cases of his own, which he calls successes, though 3 of them sooner or later required amputation. He also reported 2 cases of his colleague Orhan, previously unreported, which were failures, owing to thrombosis. These cases, with those brought out in Coenen's paper and the discussion of it, make 16 cases of arteriovenous anastomosis in addition to those previously reported in our paper, thus making in all 58 operations on 56 patients; one of Wieting's operations was done on Orhan's first case. Coenen's paper, which has already appeared in Bruns' *Beiträge*, vol. lxxv, pp. 313 to 367, is the most important of the recent contributions. His experimental work is particularly important, as showing the great difficulty in the way of the retrograde flow of blood in the veins. He showed that when dogs' vessels, the ligature of which is usually fatal, are anastomosed the operation results in an equal number of fatalities with the ligature, and that when Huerthle's stromuhr is inserted in the arteriovenous anastomosis it fails to record any flow of the arterial blood into the veins. In the discussion which followed Coenen's paper most of the surgeons took his side in decrying the practicability of this operation for gangrene. Bier and Schmieden, of Berlin, were the only ones

to express opinions favorable, though guardedly so. Save for the 4 cases which Wieting, however rightly or wrongly, calls successes, all the others of the 16 were failures when done for gangrene. Of these, 2 cases are reported by Enderlen, 1 by Quenu, 1 by Heymann, which was of traumatic origin, 1 by Payr, 1 by Riedel, 1 by Coenen, and 2 by Unger, in both of which the operator had to desist on account of the obliteration of the entire femoral artery by endarteritis. The last case, that of Goyanes, was not done for gangrene and does not really belong in this series, although it was an arteriovenous anastomosis, because it consisted in the insertion of a piece of the popliteal vein into the popliteal artery after the excision of a popliteal aneurysm. The authors since the reading of this paper have had one case of arteriosclerotic gangrene, for which, however, they performed amputation as preferable to anastomosis.]

Age.	Sex.	Operator.	Publication.	Pathology.	Result, immediate.	Remote results.	Autopsy findings.	Technique.
52	M.	San Martin	Royal Acad. of Sci., Madrid, 1902	Gangrene of great toe and part of second	Satisfactory	Gangrene spread on sixth day. Amp. thigh. Death	Obliterating endarteritis	End-to-end. Femoral vessels.
76	M.	San Martin	Same reference	Gangrene from tight bandage. Disart. of toe	Pain disappeared	Syme's amp. Wound healed. Recovery	. . . . .	Laterolateral. Impossible to make end-to-end.
47	M.	Jaboulay	Rev. de Chir., 1903, xxvii, 236	Amputation of right thigh for gangrene. Gangrene of left leg	No pulsation or other favorable signs. No change in limb	Gangrene progresses. Amp. thigh on fifth day. Death	Large vessels all thrombosed. Artery obliterated	Laterolateral, in Scarpa's triangle.
80	M.	Hubbard	Annals of Surg., Oct., 1906	Senile gangrene of part of right foot	Slight pulsation in femoral vein just below anastomosis	Gangrene extended. Amputation one month afterward. Recovery	At time of operation both tibials contained red blood	Invagination of femoral artery into femoral vein.
?	F.	Doberauer	Soc. de Med. All. de Boheme, 1907	Threatened gangrene. Embolism of brach. artery. Arteriotomy twice done	Active pulsation in vein below, continued for eight days	Not stated. Recovery	None made	Not mentioned.
36	F.	Hubbard	Bost. Med. and Surg. Jour., 1907, clvii, 185	Threatened gangrene of foot due to atheroma	Veins filled; color good; no pulsation	Gangrene extended; amputation five weeks after. Recovery	Red blood spurted from femoral vein at operation	Carrel's end-to-end.
20	M.	Lilient' al	Annals of Surg., 1907, v, xlv	Gangrene from obliterating arteritis. Obliteration of popliteal	No signs of improvement	Shock. Death in 30 hours. Death	Operation. Popliteal artery obliterated. Femoral small	End-to-end at entrance of saphenous vein.
40	M.	Torrance	Annals of Surg., 1907, v, xlvi	Traumatic; ant. tibial united to int. saph. vein	Pulsation in artery for one day; then ceased	Foot healed; artery sloughed; leg amputated four months later. Recovery	No examination of amputation	End-to-end by invagination.
56	M.	Tuffier	Bull. et Mém. de la Soc. de Chir., 1907	Syphilitic gangrene of three months' standing of foot	Vein dilated and pulsated; eight days, foot not improved	No amputation. Death on eleventh day.	Femoral artery open. Vein thrombosed	Side-to-side at apex of Scarpa's triangle.

50	M.	Tuffier	E. Cottard, Thèse de Paris, 1907–1908	Alcoholic; beginning gangrene of foot	Pulsation in vein along course of internal saphenous	Gangrene. Remained same. Pain. Improvement. Recovery	No report	End-to-end at middle of thigh.
75	F.	Ballance	London Lancet, 1908, i. 1412	Senile gangrene extending to dorsum of foot	Pulsation in saphenous and dorsalis pedis veins same day	No extension; threatened part returned to normal. Recovery	No report	Technique not mentioned.
29	M.	v. Schmieden	Ber. klin Woch., 1910, No. 13	Presenile gangrene; previous amp. of opposite foot	Anastomosis could not be made	Amputation when line of demarcation was found. Recovery	Artery found obliterated	No anastomosis.
61	M.	v. Schmieden	Ber. klin Woch., 1910, No. 13	Dry gangrene of toes on right foot	Anastomosis could not be made	No change. Gangrene remained stationary. Recovery	Artery obliterated; pulseless	No anastomosis.
48	F.	v. Schmieden	Ber. klin. Woch., 1910, No. 13	Embolic gangrene from endocarditis. Right foot amputated. Left involved	Vein pulsated. None in veins of foot. Color improved	No change in gangrene. Death day following. Death	Endocarditis; thrombosis in post. tib. Anastomosis open	Carrel's end-to-end
63	F.	Mauclaire	Arch. Gén. de Chir., 1910, v, 1, 815	Senile gangrene of right foot. Line of demarcation. Mummification	Blood entered vein. No change in leg	Amputation eight days later. No arterial blood in vein. Death	Artery thrombosed down to place of anastomosis. Vein open. Orifice open	End-to-end by invagination.
72	M.	Mauclaire	Arch. Gén. de Chir., 1910, v, 1, 815	Gangrene extending to malleoli for three weeks, to middle of leg	No improvement	No amputation. Death nine days later from exhaustion. Death	Artery found filled with clot at operation	End-to-end.
60	F.	Mauclaire	Arch. Gén. de Chir., 1910, v, 1, 815	Gangrene, whole foot (senile), spreading to leg. Aortic regurgitation	Anastomosis leaked. Artery ligated	Death from progressive cachexia in five days. Death	No report	End-to-end. Leakage. Ligation of femoral.
66	F.	Mauclaire	Arch. Gén. de Chir., 1910, v, 1, 815	Gangrene of left great toe and right index finger. Mixed senile and Raynaud's disease	Anastomosis leaked. Artery ligated	Death shortly afterward from cardiac accident. Death	No report	End-to-end. Leakage. Ligation of femoral.

Age.	Sex.	Operator.	Publication.	Pathology.	Result, immediate.	Remote results.	Autopsy findings.	Technique.
	M.	Geo.P.Mueller	Ann. Surg., Feb., 1910	. . . . .	Foot became warm. Remained warm for forty-eight hours	Amputation below knee; two weeks later death from exhaustion.	Post. tibial open. Ant. tib. closed by thrombus. Vein open	End-to-end.
84	F.	Hubbard	Ann. Surg., 1908, xlviii	Left foot. Right had been previously amputated	Leg warmer. Gangrene did not spread for one month	Gangrene progressed after one month. In two months exhaustion caused death	Atheroma. Narrowing of lumen of femoral; vein obliterated	End-to-end.
32	M.	Lund	Bost. M. and S. Jr., 1908, lix	Threatened gangrene from obliterating endarteritis	Superficial veins filled and pulsated. No other change	Gangrene of big toe; amputation. Later amp. of leg. Recovery	. . . . .	End-to-end.
40	M.	Wieting	Deut. med. Woch., 1908, xxxix	Gangrene of right leg; amputation. Pains and lividity of left	Toes and foot became warm. Pains disappeared	No further signs of gangrene after two months. Recovery	No report	Lateral implantation of artery into vein.
?	?	Orhan	Deut. med. Woch., 1908, xxxix	Gangrene of small toe. Suppurating	Warmth returned for one day; gangrene spread	Gangrene to knee. Amputation	At amputation no bleeding from any vessel. Suppuration	Not mentioned.
43	M.	Jaboulay	Charrois, Thèse de Lyon, 1908-'09, No. 85	Intermittent claudication. Cyanosis and lividity. Dry gangrene	Pulsation and distention of vein. No improvement	Gangrene spread. Leg amputated. Lung embolus caused death	Short-circuiting of blood through collateral. Thrombosis of femoral vein at anastomotic opening	End-to-end, Carrel assisted.
62	M.	Abalos	Argentina Med., 1909	Amp. of left foot. Beginning gangrene of right	Immediate pulsation of saphenous. Improvement for ten days	Gangrene spread. Amputation twenty days after anastomosis. Recovery	Femoral artery and saphenous vein both occluded	Laterolateral at Scarpa's triangle.
77	M.	Hubbard	Bost. M. and S. Jr., Oct. 7, 1909	Senile gangrene of foot	Improvement in color and warmth	Gangrene and pain; in five weeks amputation. Recovery	Red blood spurted from femoral vein	End-to-end by Carrel's method.

?	M.	Imbert	Marseille Med., 1909, xlvi	Gangrene of foot; arteriosclerosis	Vein dilated. Did not pulsate	Death on second day, cachexia. Death	Arteriosclerotic; anastomosis open	Laterolateral, femoral artery and vein.
25	M.	Imbert	Marseille Med., 1909, xlvi	Traumatic bullet wound of femoral artery, vein and popliteal artery	Pulsation in saphenous vein; gangrene	Gangrene amputation of thigh. Recovery	Artery and vein not completely united	End-to-end.
69	M.	Armour and Smith	London Lancet, 1909, ii, 919	Threatened gangrene due to arteriosclerosis	No improvement	Gangrene of leg. Amp. at upper third. Later amp. thigh. Recovery	Thrombosis of all vessels	End-to-end, double saphenous ligated.
52	F.	Celesia	Rev. de la Soc. Med. Argentina, 1909, xvii	Gangrene of foot; toes previously amputated	Improvement; pulsation of vein	Death from syncope while opening abscess. Death	Femoral vein open below anastomosis	End-to-end; ligation of saphenous vein.
69	F.	Tietze	Allg. Med. Central-Zeitung, 1910, lxxix	Gangrene of leg and foot; arteriosclerosis	No result	Gangrene spread. Death on nineteenth day. Cachexia. Death	Central end of femoral artery occluded	Termino-lateral of femoral artery and vein.
64	M.	Goldenberg	Cited by Tietze	Gangrene of right foot; arteriosclerosis	Marked improvement. Popliteal pulse reappeared	Demarcation. Death on fifteenth day. Erysipelas. Death	Vein clotted. Orifice open	Termino-lateral; femoral artery and vein.
67	M.	Jaboulay	Cited by Monad and Vanverts, Arch. Gén. de Chir., 1910	Gangrene of toe after injury and infection	Slight local improvement	Gangrene spread. Amputation seven days, of thigh four days. Death	Large clot filled femoral vein	End-to-end. Femoral artery and vein.
48	F.	Krueger	Arch. f. klin. Chir., 1910	Gangrene following discoloration and paresthesia	No improvement	Gangrene spread. Pains continued. Pirogoff amputation on ninth day. Thigh amp. on seventeenth day. Recovery	All vessels closed by thrombi	Termino-lateral, Wieting method.
63	M.	F. Mueller	Inaug. Diss., Berlin, 1910	Gangrene of great toe, left foot. Diabetes	Leg warm. Pain less. Color restored	Gangrene became limited. No improvement. Diabetic coma. Death	Wound necrotic. Opening closed. Veins competent	Termino-lateral, Wieting method.

Age.	Sex.	Operator.	Publication.	Pathology.	Result, immediate.	Remote results.	Autopsy findings.	Technique.
?	M.	F. Mueller	Inaug. Diss., Berlin, 1910	Gangrene of toe, threatened	No change except relief from pain	Gangrene of foot. Pirogoff amputation two months afterward. Later amputation of leg. Recovery	No report	Termino-lateral Wieting method
66	M.	Jaboulay	Monod. and Vanverts. Arch. Gén. de Chir., 1910	Gangrene from atheroma of right foot	Pain improved	Gangrene extended. Amputation five days later. Recovery	Anastomosis open; vein obliterated before	Jaboulay's method.
	M.	Beck	Personal communication	Frozen feet, with spreading gangrene	Demarcation occurred	Recovery	.....	End-to-end by Carrel's method.
	M.	Beck	Personal communication	Compound comminuted fracture of leg above knee	Pulsation reappeared. Warmer. Color better	Death from pneumonia after forty-eight hours	No report	End-to-end by Carrel's method.
	M.	Halstead	Original communication	Arteriosclerotic gangrene. Diabetes	Improvement. Pain less. Color better. Warmer	Death	Aneurysm formation above first valve. Thrombosis	Termino-terminal by invagination.
	F.	Halstead	Original communication	Arteriosclerotic gangrene. Diabetes	Acetonuria. Coma	Death	No autopsy	Termino-terminal by invagination.

DISCUSSION.

Dr. Howard Lilienthal, New York City.

I have been led to believe from the writings of Carrel and others, and from conversation with Carrel and from some work I have seen him do, that in normal animals it takes only about twenty minutes for the arterial pressure to force the valves of the veins. It seems to me that the real secret of this subject is the selection of the proper cases for operation, and I would like to add one more possible indication to those given by Dr. Halstead. He mentions the cases in which a considerable amount of the main artery has been destroyed by traumatism. In the man upon whom I operated, and in the average cases operated on, we have a disease of veins and also of arteries, in other words, an obliterating thrombo-angeitis, and it does no good to anastomose one diseased vessel with another.

I do believe there are cases in which gangrene is due to disease of the arteries alone, and here the operation of anastomosis should be tried before amputation is recommended.

There is another class of diseases in which this operation should be performed, namely, embolism of an artery with resulting gangrene of the foot. If the embolism is low down and has existed so long that it cannot be removed, an arteriovenous anastomosis of the femoral vessels will give at least a chance to cure the disease.

Dr. Fred B. Lund, Boston.

Dr. Joshua Hubbard, on our hospital staff, became interested in arteriovenous anastomosis in senile gangrene and operated on several patients, for one of whom I had already amputated the other leg. I never could see any definite benefit from these operations, for the arteries were sclerosed. About that time there came to me a young Hebrew who had what I thought was an obliterate enteritis. This young man did not want to lose his foot, and I thought there might be enough healthy vessels to carry out an anastomosis. I divided the femoral artery and vein and made an end-to-end suture. The vessels were so large that it was not difficult. It did not take long, and I did it by mattress sutures of silk; the vein filled right up and pulsated beautifully, and the toe swelled up and got warm and dark purplish pink. But shortly the gangrene went on, and I said, "If there is any benefit in this thing I will see if amputation of the toe will do any good," but without the desired result. Then I amputated below the knee; the stump did not heal; then I did a thigh amputation. Then an examination was made, and we found the veins full of thrombi which were organizing except at the upper end, and the

artery was full of thrombi also. Four or five years later he presented himself with the same condition in the other foot, and I do not think I shall advise arteriovenous anastomosis on this other leg. It is now recognized that this disease is a thrombosis of both veins and artery, with organization of the thrombi, a "thrombo-angeitis obliterans."

Dr. Leo Buerger had traced out beautifully the venous distribution in the leg, and shown that in some cases we may find some veins which will take up the circulation enough to make arteriovenous anastomosis efficient. I do not, however, think it will often be practicable, and I agree with Dr. Halstead's conclusions as to the very great limitations of the value of this operation. I hesitate to speak from one case, for I think Dr. Buerger's investigations are admirable and thorough.

Dr. R. T. Vaughan, Chicago (by invitation).

Dr. Halstead's first case, in which, in spite of a high degree of obstruction at the first valve, with some aneurysmal dilatation above it, a fairly satisfactory clinical result was obtained until thrombosis occurred, suggested to me that it might be possible to obtain a more brilliant operative result, at least temporarily, in such cases if only the resistance of the valves in the veins, especially those close to the site of the anastomosis, could be broken down.

The observations of Carrel and Guthrie on dogs, that valves at first competent become permeable as dilatation of them gradually takes place when exposed to arterial pressure, suggested a possible remedy.

I determined to ascertain whether the subjection of the veins to a pressure equal to or higher than that of the arterial circulation, and yet below that which would rupture them, would not dilate the veins at once, make the valves thereby permeable, and thus remove a considerable hindrance to the penetrating of the arterial blood after performance of the anastomosis. This procedure I undertook to perform at first with normal salt solution; but finding it difficult to trace definitely enough the course of the injection, I had recourse to a carmine and glycerin mass recommended by Mallory and Wright. In order to prevent blood clots from interfering with the backward passage of the injecting fluid through the veins and capillaries, I first washed out all the vessels of the legs with an 8 per cent. sodium sulphate solution, which I injected through the abdominal aorta. As soon as this fluid came away clear through the vena cava, I then proceeded to inject each femoral vein below the profunda vein with the carmine injecting mass.

In order to obtain a high pressure without too sudden changes in the pressure I made use of a 100 c.c. metal syringe, the plunger shaft of which is provided with a thread so that the plunger can be screwed into the barrel and much force thereby applied. This is the syringe which Dr. Halstead uses for his bismuth paste and paraffin injections. When the plunger is well coated with vaseline the pressure which can be exerted by this syringe is sufficient to rupture the wall of the vein if its outlet be cut off and sufficient force applied, a pressure doubtless equal to several atmospheres.

Having several rabbits available, I first tried the method on them, but without entirely satisfactory results. Their vessels are so tiny and contract so markedly, even after death, to mechanical stimulation, that it is very difficult to enter them even with the smallest cannula, and even when successfully intubated the necessary ligatures are very apt to rupture the vein walls, particularly at the time the fluid is injected and strain put on the ligatures.

In one case, however, even in the rabbit, I was able to force my injecting mass past the valves in the femoral vein so that the red fluid injected the dorsal veins of the foot; but not enough carmine passed the valves or capillaries to make any showing in the femoral artery. There was much dilatation of the femoral vein directly above the upper valves, particularly above the first one.

No human cadavers fresh enough so that blood clots would not be filling the vessels and capillaries were available. Therefore, I had recourse to dogs, with distinctly more success than with the rabbits. In each one of three dogs I was able to inject the dorsal veins of the feet on each side by way of the femoral vein opened just below the profunda. In two of the cases sufficient of the injecting mass passed down the veins and through the capillaries to make a distinct trickling return flow in the femoral artery. The failure to return an arterial flow in the third case may have been due to the capillaries not being washed entirely clear of blood clots, or to my injecting mass not being ground up as finely as in the other cases, and therefore not so readily passing the capillaries. At any rate, in all three cases the red mass successfully passed the valves in sufficient quantity to inject distinctly all the veins of the leg and foot. There was much pouching above the upper valves and occasionally a little suffusion there when the pressure had been sufficient to rupture a tiny vessel or two in the vicinity. Such a suffusion is a sign of too great pressure; and before this degree is reached the valve has already become incompetent in part, though it seems never to cease making some resistance to retrograde flow.

I believe I am justified, therefore, in concluding from these experi-

ments, relatively few as they are, first, that it is possible to inject the veins and capillaries of the feet in the retrograde direction by way of the femoral vein, opened below the profunda, the possibility of which has been denied by Delbet, Gallois and Pinatelle, and other skeptics, who maintain that fluid passing through the femoral vein in the retrograde direction will always be short-circuited into the superficial veins before it can reach the peripheral veins and capillaries. Secondly, that if such an injection mass would reach the periphery, normal salt solution under similar pressure would do the same. Whether after this procedure of preliminary normal salt injection plus arteriovenous anastomosis the arterial blood would penetrate as far as the injection does, and if so, whether it would penetrate in sufficient amount to support life in the parts, is another question which is not answered by these experiments.

That, however, such an attempt carefully conducted would present no disadvantage over our present procedure, and might improve it, diminishing valvular resistance somewhat, seems to me not improbable and worth trying if we have another case in which the performance of arteriovenous anastomosis seems justifiable.

Dr. John B. Murphy, Chicago.

Dr. Halstead's paper and all that pertains to the arterial and venous degenerations greatly interests me. If the artery and vein are both healthy, an anastomosis can be made and the opening remain patent if the proper technique be executed. This law, however, does not apply to the class of cases cited in Dr. Halstead's paper. Anastomoses of healthy bloodvessels have been produced accidentally, by bullet and stab wounds, again and again. I recall, in my early experience in 1886, an anastomosis of the jugular vein and the carotid artery caused by a bullet; I separated the artery and vein and closed the openings with continuous silk suture; a perfect result followed, curing the arteriovenous aneurysm.

With regard to the observations made in arterial degeneration and the absence of venous degeneration, I cite an interesting case illustrating this condition. It occurred in a male, aged forty-three years, of Semitic extraction; he had all the symptoms of renal colic, with complete suppression of urine; some years before there was a diagnosis of "occlusion of the ureter" on one side. Two and one-half years ago one leg was amputated by me for arterial degeneration and gangrene. In the attack to which I refer no urine had been passed for five days, and we decided there was a collection of urine in the pelvis on the left side, and therefore operated on the left kidney, believing that the suppression on the right was reflex from a calculus

in the left ureter. The kidney was exposed and found dark, gangrenous, and necrotic. The other kidney was exposed, dark and gangrenous, also dead. Both renal arteries were completely occluded. Both veins were patent clear to the pelvis, showing that in this locality the veins did not undergo degeneration with the arteries, as stated in the paper quoted by Dr. Lund.

The endarteritis had produced a spasmodic ischemia of the kidney, giving each time his symptoms of "calculus," in the way of renal colic, blood in the urine, etc. The *x*-rays, however, were negative, showing that the patient survived the arteriosclerotic condition of the renal artery, three years after the initial symptoms, just the same as the heart for many years survives the initial symptoms of coronary sclerosis.

In our hands, arteriovenous anastomosis for gangrene due to endarteritis obliterans has been, from a practical standpoint, a uniform failure, whether the lesion was of spirochetic or renal origin, while arterial and venous suture of healthy vessels for injury or aneurysmal dilatation has been very gratifying.

A STUDY OF PYLOROPTOSIS; GASTRIC ATONY AS THE ORIGINAL CAUSE OF NEURASTHENIA, AND ITS CURE.

By ARCHIBALD MacLAREN, M.D.,
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AND

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Less than one year ago we decided to make a series of *x*-ray investigations of the stomach to determine its size, position, and motility. As the digestive act is always performed while the patient is in the upright position, we decided to take pictures while the patient was standing. In these pictures a preparation of bismuth oxychloride has been used, because it has been demonstrated that the gastric secretions have no chemical action on this form of bismuth, and the influence of the normal acidity on the pyloric contraction is therefore present, and, most important, there is no danger of poisoning when using this drug. We were surprised to find that all of our pictures showed the stomach hanging vertically down in the abdomen, hung from the esophageal opening, slightly curved to the right at the bottom like a big letter J. The anatomical description of the stomach as usually given is correct when the patient is lying down, but gives no idea of the great range of motility of the organ. The anatomists have been working at a great disadvantage because they have been studying the stomach in postmortem specimens. It must be remembered that a living stomach is different from the dead, flaccid sack seen in the postmortem room. Surgeons, too, have been at a disadvantage because they have studied this organ when the patient was prone, lying on the operating table. We can also readily see that the

administration of an anesthetic with its consequent nausea would probably change not only the position of this organ, but also its shape. The pyloric end is described as usually crossing the spinal column at the first lumbar vertebra, and this is probably true when the patient is prone, but when in the upright position we find it frequently crossing at the fifth lumbar.

The ordinary method of determining the position of the stomach in the abdomen is by inflating it with gas or air, but we can readily see that inflation would make the organ rise in the abdomen, much like an inflated bladder in a barrel of water.

Hallings showed some time ago that the stomach is supported by the intestines, and that they have in the abdomen about the same specific gravity as water.

You will notice in the pictures of all of these stomachs that there is a constriction of the circular fibers about half-way between the pylorus and the fundus, giving an hourglass effect, and while we cannot demonstrate any increase in the circular muscular fibers at this point, it is possible that this may in some way be related to the antral sphincter which divides the stomach in half in lower animals. Several observers have, we believe incorrectly, described these normal stomachs as hourglass deformities.

Early in our investigations we found that many stomachs were very markedly prolapsed, but that their owners had perfect digestions. Gastroptosis without symptoms was an explanation offered, but when we found that most healthy women and many healthy men had stomachs hanging well into the pelvis, we came to the conclusion that in the upright position the pylorus was usually a pelvic organ. When we came to take pictures of the neurasthenic patient, we at once found that the stomach was in the same position, but flaccid, baggy, and flattened at the pylorus, showing marked lack of tone of the stomach wall; and we soon discovered that the most of these people without tone had been operated upon for removal of the appendix, but that they still had their right-sided pain and tenderness. As their appendices had been removed and the upper point of tenderness did not correspond with the position of the gall-bladder, we were at a loss to explain their attacks of colicky pains in the right abdomen. Later, several of these people came to us from other medical men with

the diagnosis of chronic appendicitis, desiring operation. Several already observed were our own cases, where removal of the appendix had failed to effect a cure. They were usually of the neurasthenic type so well described by Reynolds before this Association one year ago. Many of them had discovered for themselves that their discomfort which came about one hour after eating could be relieved by lying down, which we believe is a valuable point in making a differential diagnosis.

FIG. 1.—Normal stomach.

When we found that young children had these same atonic stomachs without other prolapsed viscera we commenced to understand the course of events at least in a certain class of early neurasthenias.

The digestive function of the stomach is, we believe, chiefly mechanical rather than chemical; a storehouse for food and an organ for the churning and grinding of the food, so that it may be ready for the really important intestinal chemical digestive processes. Now, as we look at a dilated prolapsed stomach and realize that when the patient is in an upright position the

FIG. 2.—Case I. Before treatment.

stomach, after it has prepared the food, must lift it over the duodenal hill, at least some five inches of height, before any real digestion can take place, we realize that its muscular power must be up to normal or the patient will commence to be uncomfortable, and will, as a result, starve himself and so will soon lose weight.

This, in truth, is just what happens whenever the child or grown person loses flesh or strength from any cause and becomes weak and debilitated. Under these circumstances the stomach wall relaxes, the pyloric end sags, and the food cannot be lifted into the duodenum. Fermentation commences and the digestion becomes painful. Distinct attacks of pain are frequent; the greatest distress, as we have said, is usually referred to the right

FIG. 3.—Case I. After two months' treatment.

abdomen, at first one or two hours after eating; later the discomfort becomes constant, spreading all over the abdomen, sometimes with nausea, occasionally with vomiting. This distress almost never comes at night, and is often relieved by eating, more frequently by lying down, especially if the patient lies on the right side.

When the digestion becomes painful the patient starves himself, or more often herself, and so aggravates and intensifies the condition, rapidly drifting into the condition which we speak of as true neurasthenia. Stiller thinks that these conditions are congenital. The fact that these people can be so easily cured proves to us that they are not congenital. They undoubtedly

FIG. 4.—Case II.

inherit a weak constitution or a favorable soil for the growths of all these complex nervous symptoms. Whether congenital or acquired, we think we have seen the earliest signs, or the first stages of neurasthenia in this stomach atony in young children, who, by the way, react much more promptly to intelligent treatment, so that for a time at least we have been able to put off the

evil day. Goldthwait appears to think that some of these cases are due to postural errors, whereas we believe that the faulty attitude and carriage are late symptoms of the general relaxation due to starvation.

In regard to the etiology of this condition we believe that gastric atony is closely allied to acute dilatation. Payer has

FIG. 5.—H. B., aged thirteen years. Pain in lower right abdomen. More marked after exercising. Marked improvement under treatment.

recently described the milder forms of acute dilatation, which often pass unnoticed. We believe that after illness, shock, grief, etc., occasionally a mild acute paresis of the stomach will occur, which if unrecognized and untreated passes on into a chronic type which we see in these typical neurasthenic atonic stomachs.

TREATMENT. The observations of Makovic and Pevussia (*Medical Klinik*, 1910) showed that position has a most marked influence in accelerating or retarding the passage of food from the stomach, making an increase of almost three hours in the emptying of the stomach when the patient was lying on the left side, as

FIG. 6.—D. W. M., aged forty-five years. Present symptoms of gastroptosis. Operation: Gastroplication, using silk sutures in anterior wall of stomach.

against the same position on the right side. Consequently, in dealing with these people the first thing to do is to describe to the patient the condition as shown in the picture and tell him the results that he may hope for if he will help to empty his own stomach by lying down on the right side when he has pain.

The internal medical man and the neurologist have for years

been able to make most satisfactory cures of these patients. They have known that the rest cure with a special nurse and several weeks' stay in the hospital would cure these patients, but it seems to us that they have not quite understood why they got such good results. Later, when these patients had recovered, many of them relapsed because they were not properly instructed as to their future behavior.

FIG. 7.—Same case as Fig. 6, two months after forced fat feeding and rest cure.

But what is to be done for the working woman, for the shop-girl, who cannot afford all of these luxuries? Must she be abandoned to her fate? We believe that we have very materially helped a considerable number of these people without a formal

rest cure and without medicine, and usually without an operation. If an operation has to be performed for some absolute physical or mechanical condition which interferes with the nutrition of the patient, they should be kept a much longer time in bed, and during their convalescence should be started on the line of forced fat feeding. After an operation it is always a mistake to let these people go home too early.

FIG. 8.—Mrs. B., aged forty-three years. Patient of Dr. C. L. Greene. Presents symptoms of general ptosis and neurasthenia.

In regard to operations upon the stomach itself, if we are correct in our interpretations of these stomach plates and if the symptoms in these cases are due to loss of normal muscular power, as we believe them to be, then it would seem as though gastro-enter-

ostomy, gastroplication, and gastrosuspension would accomplish little if any good, because operations upon the stomach itself will not increase the muscular strength of this organ, and the few days' operative starving will take away a little more flesh and strength and make the general condition worse.

FIG. 9.—Same case as shown in Fig. 8. *X*-ray picture taken six and one half hours after bismuth meal was given. It shows a large portion of the meal remaining in the lower part of the stomach.

We have tried gastroplication of the stomach by putting two or three rows of silk suture across its long axis, raising temporarily the site of the pylorus. A second picture, taken a few weeks later, showed the stomach to be of much the same size and practically in the same position as before the operation. These patients were

a little better, but we believed that the improvement was due to the rest cure and the forced feeding, rather than a result of the operation. We have seen several of these stomachs where gastro-enterostomies have been done without benefit. Some of them were our own failures, done at a time when gastric ulcers were supposed to be multiple and when calloused ulcer was supposed to be the exception, not the rule. If gastro-enterostomy is ever justifiable in these cases, Bach is no doubt correct when he claims that the ordinary short-loop operation only kinks the intestinal opening, and that if any operation is done it should be the Roux enterostomy en Y. At present, however, we believe that these people do not do well after any operation, that they are medical and not surgical in character.

In regard to gastrosuspension, we have seen some which did not hold, as, for instance, the case reported at the end of this paper. Eve, Rovsing, and Beyea all regard this neurotic condition, which we have been discussing, as a consequence of the gastroptosis, or better, pyloroptosis, but they all express the opinion that gastropexy should be done in these cases, and that this operation will cure the disease. Our observation in this and in other fixation operations is, that when we suture living tissue and especially muscular organs like the large intestine or the stomach, any suture which is strong enough to hold is almost certain to cut through in a few days, letting the organ soon fall back into its former position. Recently we tried to fasten a dilated obstructed cecum into the abdominal wound for the purpose of making a fecal fistula; the stitches had all cut out the next day and the intestine had drawn back into the abdominal cavity. Gerster, in the last *Progressive Medicine*, believes that the American surgeon is not ready to accept gastropexy as a cure for pyloroptosis. On the other hand, without any operation we have seen most marked improvement in many of these patients. These people are easily affected by a faith cure, but imagination will not make them put on flesh.

Case I.— Mrs. G., aged forty-six years, three children, youngest aged seventeen years. She had been a patient of my old friend Dr. A. J. Starr, of St. Paul, until his death. She was a tall, thin, anemic neurasthenic, five feet nine inches in height, and weighing 118 pounds. For many years she had suffered from attacks like

gastric ulcer, frequent attacks of vomiting of large amounts of fluid, having vomited blood on two occasions. Her stomach was very low and atonic, as shown in Fig. 1. In two months' indifferent treatment by herself, posture, and forced fat feeding, she had gained 16 pounds, and was almost perfectly well. Her stomach now shows good muscular power (Fig. 2).

CASE II.—Miss K. was curetted for dysmenorrhea ten years ago. Eight years ago she still had dysmenorrhea, right-sided, and backache. She had a retroverted uterus and was markedly tender over her appendix. At that time I removed the appendix, which contained four good-sized enteroliths, and she was better for a time, although her right-sided dysmenorrhea continued as before. She was soon married, and in February, 1904, her first baby was born. This relieved her of her dysmenorrhea, but she continued to have such marked gastric trouble, with gas and vomiting attacks, that four years ago she had a gastro-enterostomy by Dr. S. This so increased her discomfort that two years ago Dr. Wm. J. Mayo unfastened the gastro-enterostomy and suspended the stomach with two linen sutures, fastening the gastrocolic omentum to the suspensory ligament of the liver. It goes without saying that no one could have done it better. When she came to us four months ago she was a nervous wreck, unable to do her work, almost insane from neurasthenia. The *x*-rays showed the typical prolapsed, atonic stomach which could not empty itself. Forced fat feeding and rest after meals changed this picture, so that in four weeks she gained 8 pounds, and said: "I am well; I have not felt like this for years." Her stomach was practically in the same location that it was before her cure.

CONCLUSIONS. 1. Position of the stomach is not important, since the pylorus is practically a pelvic organ.

2. The principal function of the stomach is mechanical.

3. The beginning or first symptom of the so-called neurasthenia is due to gastric atony.

4. Postural drainage and fat feeding, temporarily at least, cures these patients.

5. From our present experience we believe that operations on the stomach to change its position and help its drainage have still to be proved advisable, because no operation will take away the muscular atony, but will rather aggravate it.

DISCUSSION.

Dr. Stanley Stillman, San Francisco.

With the general proposition Dr. MacLaren makes that these cases are not cases for surgical interference, I am very heartily in accord, partly on account of my own experience, which is not great, and partly from my knowledge of the results of other men's work in the same line. In all of them the results of operation have been so very unsatisfactory that of late I have refused to do anything surgically for these large dilated stomachs with atonic walls. A couple of years ago I tried the experiment of removing the entire pyloric half of the stomach in one of these cases, hoping that by getting rid of the pyloric reflexes the condition might improve. The woman was better for several months—as are all of these neurasthenics for a time—and then her condition became as bad as ever, or nearly so. At the present time, there is retention in the remaining half of the stomach which is dilated to nearly the size of the original stomach. I do not believe that surgery will prove of any benefit in such cases. The stomach is so low and the retention so marked that medical men naturally feel that this calls for drainage, and oftentimes insist that this be done. My advice now invariably is to leave these cases entirely alone surgically.

Dr. William J. Mayo, Rochester, Minn.

I quite agree with what Dr. MacLaren has said—that these cases are not surgical. In regard to the particular case of which Dr. MacLaren speaks, we have seen a number of such in our clinic; instances where a gastro-enterostomy for prolapse, atonic dilatation, or gastric neurosis had been made and the patient suffered more than before. We have made a complete separation of the anastomosis in these cases, and restored the patient to her original discomfort, which was less than those introduced by the operation. At one time we held the view that Dr. MacLaren now holds, that is, that the trouble was mechanical, but I hope his belief is based on better premises than was our own. The mechanical explanation of the phenomenon is enticing, but, I believe, incorrect. Dr. MacLaren thinks that if we turn the patients on the right side after each meal we get better mechanics, and at least that there is marked improvement. Perhaps by this means it is suggested to the patients, three times a day, that they are to get better, and as this group of patients are largely of the neurotic type, they are extraordinarily susceptible to suggestion. Christian Science, Osteopathy, and the various fads all show success for a time.

The neurasthenic group of patients are most troublesome. Every operation made, whether it is on a lacerated cervix or movable kidney, or elsewhere, seems for a time to give a certain temporary betterment in the condition of the patient, but, as Dr. MacLaren has said, in the long run an unsuccessful operation is a distinct detriment to the patient.

With regard to Arbuthnot Lane's idea of some poisoning or intoxication arising from the colon, I think there may be something in it. Finney reports three such cases in which he resected the transverse colon, and his patients got a good deal better. Dr. Blake reported some carefully selected cases that had had betterment follow operations on the colon. The whole point hinges on whether it is possible that there is secreted in the colon of these people something, say a toxin, which is absorbed, and that all their gastro-intestinal disturbances are the result of such an intoxication, thus comparing them to the effects of hyperthyroidism as a cause of Graves' disease, cases now admitted to be caused by an excess of thyroid secretion. These cases of neurasthenia of the gastro-intestinal type might be said to suffer from a subconscious insanity, a condition which might be produced by some chemical or toxic substance secreted in their own bodies. I have not the slightest idea of operating on these cases as yet, but somewhere there must be a germ of truth which will come to the surface, and we may find that these patients are actually poisoned in some such way from the colon.

Mr. Harold J. Stiles, Edinburgh.

This subject is one which has interested me ever since Dr. Mayo taught me how to do a gastro-enterostomy properly. When I learned how to do that, and cure duodenal ulcers, I began to ask myself why cannot one do something for these poor neurasthenics with dilated stomachs who are not only a nuisance to themselves but to everyone else? I must say I was inclined to think that a drainage gastro-enterostomy would do good, provided we compel the contents of the stomach to pass out of the new opening, and with this object in view I closed the duodenum. I was very gratified with the result, and since then I have operated on 12 cases. Only three years have elapsed since my first case was done. No patient has been made worse, one or two have remained in *statu quo*, and the rest have been materially benefited. Very recently I got a full statement from each patient, and so far as my experience goes I am strongly inclined to continue to do the gastro-enterostomy with a good big opening, but only on the condition that I am permitted to close off the duodenum. I have never seen any regurgitant vomiting afterward.

As most of us will agree, there is less postanesthetic vomiting after gastro-enterostomy than after any other abdominal operation.

With regard to Mr. Lane's idea, I have always felt that chronic constipation is one of the causes of atonic dilatation of the stomach. Chronic constipation acts upon the stomach in the same way that hypertrophy of the prostate acts upon the pelvis of the kidney. You have practically an intermittent obstruction; there is no escape, or insufficient escape, at one end of the bowel, yet the patient is continually pouring liquid and food into the other end; the result must be a backward pressure, a damming back of the fluid in the small intestine into the duodenum, and a dilatation of the pyloric end of the stomach. When that occurs—and we find in practically all chronic dilatations that the pyloric sphincter is absent or nearly so—a stomach stasis occurs. The patient does not, therefore, get properly nourished, and so becomes neurasthenic. By allowing the food to escape from the stomach more readily, you will so improve the primary digestion and the nutrition of the patient that the neurasthenia will gradually disappear. My experience has been that there is a distinct tendency to improvement in constipation by doing a gastro-enterostomy and closing the duodenum.

Dr. MacLaren. One reason which proves to me that there must be something in this theory was the gastric atony in children who came to me following the first attacks of colic without other evidences of gastroptosis. You cannot suggest to a twelve-year-old child as you can to a neurasthenic woman; then, again, they are the most responsive to the milder forms of treatment, such as taking them out of school, superintending their diet, etc. You cannot get away from the fact that the internal medical men and the neurologists have cured many of these cases without anything more than rest and fat feeding, and I used to see a great many of these people in consultation, and often believed that they should have some immediate surgical interference; then the medical man would say that just as soon as he could get the patient in condition the operation should be performed; by the time the patient was in good condition the necessity for the operation had disappeared. If these improvements and cures are by suggestion, as Dr. Mayo thinks, I believe it is a good method, for it gives us something else than the old suspension operation, and takes us away from any operative suggestion, which seldom did these patients any good.

ULCER OF THE STOMACH AND DUODENUM, WITH SPECIAL REFERENCE TO THE END RESULTS.

By WILLIAM J. MAYO, M.D.,
ROCHESTER, MINNESOTA.

On January 17, 1911, we (C. H. and W. J. Mayo) completed a series of 1000 operations upon the stomach and duodenum for indurated ulcer. The total number of cases operated for ulcer was considerably more than 1000, but the only ones considered in this study were those in which an actual demonstrable ulcer existed—that is, one that could be seen and felt in the stomach or duodenal wall. All of the so-called clinical, medical, and mucous ulcers have been excluded because of insufficient evidence of the actual presence of an ulcer.

The question as regards the existence of a group of ulcers in the stomach and duodenum, chronic in character, which are non-indurated and confined to the mucous membrane, must still be held *sub judice*. That acute mucous ulcers exist as a result of toxic poisons cannot be doubted, but all the evidence which we have at hand goes to show that acute ulcers heal if the patient does not succumb meanwhile to perforation or hemorrhage.

These acute ulcers and mucous erosions are almost always multiple and are caused by a variety of gastrotoxic substances. Toxic erosion of the gastric mucosa is the usual cause of the gastric hemorrhages which accompany cirrhosis of the liver, splenic anemia, and certain other disordered blood states.

Acute mucous ulcers apparently do not give rise to the chronic indurated ulcers, at least in going over the histories of the indurated ulcers which we have operated, few, if any, could be traced to this acute condition. Nevertheless, I suspect that

mucous ulcers, fissures, or erosions of a chronic character may exist and show no evidence of their existence on the exterior of the stomach, but such conditions must be rare. On several occasions we have examined the stomach and duodenum through an abdominal incision without finding any evidence of ulcer, and the continued symptoms for some months led to a second exploration when an ulcer was discovered. Either the ulcer had been overlooked at the primary operation or it had been confined to the mucous membrane and the musculoperitoneal coats were involved later. This is a question which must be cleared up by further investigation, but until we can secure stronger clinical evidence than is now at hand, an ulcer must be demonstrated by sight and touch before its existence can be regarded as proved.

In a few instances we have incised the wall of the stomach and searched the gastric mucosa for mucous ulcer, but the results were rather uncertain. The gastric mucosa bleeds easily on manipulation and the question arises, Was the lesion which was found in the mucous membrane caused by the instrumentation or was it present before the examination?

The proximal duodenum above the common duct is embryologically, functionally, and pathologically closely related to the stomach, although morphologically it has the appearance of the small intestine. Its mucous membrane is thin and granular, without valvulæ conniventes, and it does not have any great degree of muscular action. I have seen muscular contraction in the stomach and practically all parts of the intestinal canal, but I have never seen a peristaltic wave in the first four inches of the duodenum.

That benign ulcer was a disease of the stomach and rarely found in the duodenum, was a dictum accepted until within recent years. Of the 1000 cases in our series, 428 were classified as gastric and 572 as duodenal. This is not a fair relative percentage because the earliest cases in which an ulcer was found in the vicinity of the pylorus were classified as gastric and in all probability many of them were duodenal in origin.

Previous to June 1, 1906, 379 cases of gastric and duodenal ulcer were operated. Of these, 227 (59 per cent.) were classified as gastric and 152 (41 per cent.) as duodenal; *all of the ulcers around the pylorus being classified as gastric.*

From June 1, 1906, to January 17, 1911, 621 cases of gastric and duodenal ulcer were operated, of which 201 (32½ per cent.) were gastric, 401 (64½ per cent.) duodenal, and 19 (3 per cent.) were shown to have an ulcer of each viscus. That at least 2 out of 3 cases of ulcer will be found to have their origin in the duodenum rather than the stomach is a conservative estimate.

That benign ulcer was more common in women than in men was another almost universally accepted statement. Of our 1000 cases, 255 were women and 745 (practically 3 out of 4) were men.

Another erroneous opinion tenaciously supported concerned the number of ulcers present in the involved organ; it being alleged that multiple ulcers were the rule. While this is quite true of acute toxic ulcers, it is certainly not true of the chronic indurated ulcer, more than 95 per cent. of which are single.

A study of the symptomatology of gastric and duodenal ulcer demonstrates that the greater number are situated within two inches of the pylorus, and that all of these ulcers give a fairly definite clinical picture; pain coming on from one to three hours after meals, often in the night, and relieved by taking food, alkalines, etc. In the early stages hyperacidity is a fairly constant symptom, although when there is obstruction or the disease exists in individuals in the latter decades of life, the acidity may be normal or below normal. Hypersecretion, giving rise to sour belching and eructations of acid fluids, is a prominent feature and one that is more persistent than hyperacidity. Hemorrhage, both obvious and occult, is less important in the diagnosis than we were led to believe, and so far as hematemesis is concerned, it can only be accepted as indicative of chronic ulcer when it is preceded and followed by other symptoms of ulcer.

The most important diagnostic sign is food retention, not necessarily the gross obstruction, but the finer degrees of obstruc-

tion causing small particles of food to be found in the stomach eight, ten, and twelve hours after meals. Other things being equal, food retention is an indication for surgical interference.

The patient with ulcer of the body of the stomach often gives a confused history, such as pain coming on soon after eating and most severe to the left in the region of the body of the pancreas. When the symptoms are clear but not orderly in arrangement, the location of the ulcer will often be responsible for the disorderly symptoms.

A differential diagnosis between duodenal and gastric ulcer can usually be made without difficulty, but it is not essential. It has been generally observed that the location of the lesion is usually duodenal if there is a long interval between food and pain, and especially in such cases if the point of pain is a little to the right of the median line as well as in the epigastrium. Another very common source of error in differential diagnosis lies in the frequent association of ulcer with gallstones, appendicitis, etc. We have frequently been able to establish these three independent conditions before operation.

Every operation upon the stomach should be preceded by a careful examination of all the organs which might harbor diseases having similar symptomatology; a differential surgical diagnosis at the time of operation is quite as essential as a differential medical diagnosis before operation.

The indications for the surgical relief of chronic ulcers of the stomach and duodenum are both positive and relative: positive if obstruction, repeated hemorrhages, and severe pain exist, or, if on account of disturbed digestion, the patient is insufficiently nourished; relative, when for any or all of these reasons the patient is unable to maintain good physical condition on the food which circumstances permit him to obtain, and his chronic disability interferes with his vocation.

A study of the end results in this series of cases has been made for the purpose of showing what surgery has actually accomplished in this field. We have made a classification as follows:

1. Gastric ulcers. (*a*) Ulcers with obstruction, pyloric or hour-glass. (*b*) Ulcers without obstruction, usually ulcers of the body of the stomach.

2. Ulcers of the duodenum treated by (*a*) gastrojejunostomy with or without infolding the ulcer. (*b*) Ulcers excised with or without pyloroplasty or the gastroduodenostomy of Finney.

The operative mortality in our series of 1000 cases, including all classes of operations and all causes of death was 2.4 per cent.; 379 of these patients were operated upon previous to June 1, 1906, before the operative technique had been well worked out, therefore imperfections in methods were responsible for some failures to cure and a higher mortality. However, it may be stated in a general way that in all the earlier cases in which there was obstruction, the results were favorable. Fortunately, but few cases were operated upon during the early period unless obstruction was a marked symptom, the average percentage of recoveries was therefore high. The proposition still holds good, that ulcers which cause obstruction, either potential or actual, present a high percentage of cures.

In 19 cases of duodenal ulcer, the ulcers were excised with or without pyloroplasty or the gastroduodenostomy of Finney. The cases in which excision, with or without pyloroplasty, was done were not so satisfactory as those treated by gastrojejunostomy, and two out of this small group of cases required secondary gastrojejunostomy, before a cure was accomplished. The explanation of this appears to lie in the fact that after plastic operations about the pylorus crippling adhesions are prone to follow, and while an adequate opening can be made, the progress of food is apt to be delayed and painful. The gastroduodenostomy of Finney gave much better results than those following pyloroplasty. In fact, the late results in all the cases in which we have employed the Finney operation were excellent.

In studying the histories of the gastric ulcers we found that practically all which were situated close to the pylorus and accompanied by obstruction were relieved by gastrojejunostomy whether or not the ulcer was excised. However, whenever it

was possible to do so, we excised the ulcer because of the liability to cancerous degeneration. For obstruction of the pyloric end of the stomach, and for ulcers of the duodenum, gastrojejunostomy appears to furnish practically an equal percentage of cures.

Gastrogastrostomy and gastrojejunostomy as a method of treatment for obstruction due to hour-glass stomach have given good results. With the view that the scar tissue found in the hour-glass stomach was a cancer menace, whenever possible we have made a transverse resection of the hour-glass contraction including the scar tissue with circular end-to-end union. While the results have been satisfactory, I believe that, taken all in all, these patients do not experience the complete relief which occurs when gastrojejunostomy is a part of the procedure.

Ulcers of the body of the stomach without obstruction, especially those deep excavations adherent to the pancreas, etc., have given the least satisfactory results following excision. In some of these cases the symptoms redeveloped to a greater or less degree, and a secondary gastrojejunostomy was necessary for relief. A combination of gastrojejunostomy and excision gave much better results than excision alone. It is notable that following excision there was more or less failure to cure when there was ample lumen in the stomach distal to the part excised, and even with excision and gastrojejunostomy the results have not equalled those obtained in pyloric stenosis and duodenal ulcers. When we explored later to learn why these patients had not recovered, as a rule, we found the site of the former operation fixed by adhesions. This has been particularly true following excision of ulcers in the posterior wall of the stomach when adhesions to the pancreas were found at the time of the primary operation.

In some cases, when a gastric ulcer was difficult of access and not large, instead of excising, we have applied sutures in such a manner as to cut out the ulcer base, and have then covered the part with a second row of musculoperitoneal sutures. This procedure is simpler than excision, but it is applicable only to

those ulcers having but a moderate amount of induration and in which excision would be difficult and dangerous.

In experimental studies which Maury made in the normal dog. it was shown that a pentagonal compression stitch can be applied to any hollow viscus in such manner as to destroy the included part with certainty.

In a few of the cases very extensive ulceration of the body of the stomach precluded the employment of any operation upon the stomach, and jejunostomy for jejunal feeding, with complete rest of the stomach for some weeks has been necessary. Clairmont has advocated this plan strongly in such cases and in the few instances we have practised it the results were good.

From the above data it is very evident that operations for duodenal ulcers present a higher average of cures than operations for gastric ulcers. Gastrojejunostomy, with or without infolding the ulcer, not only affords great relief to the patient with duodenal ulcer, but a permanent cure in a remarkably high percentage of cases,

These statistics indicate: (1) That the treatment of all duodenal and all obstructing ulcers of the pyloric end of the stomach by gastrojejunostomy and excision, or infolding the ulcer, is satisfactory and gives 98 per cent. of cures or great improvement. (2) 85 per cent. of ulcers of the body of the stomach will either be cured or greatly relieved by excision, or devitalizing suture compression with gastrojejunostomy. The remaining 15 per cent. will be more or less benefited. In addition, closure of the pylorus may be practised with benefit. The operative mortality under present methods is less than 2 per cent.

I am indebted to Dr. George Eusterman for tracing these patients and ascertaining their present condition.

DISCUSSION.

Dr. Fred. B. Lund, Boston.

I am very glad to hear Dr. Mayo speak a good word for jejunal feeding, as I have found it enabling me to nourish a patient having a perforating duodenal ulcer, and I am just employing it in a case I hope will be successful in a chronic ulcer. I think it an important recourse which we do not use often enough.

Dr. John E. Summers, Omaha.

I would like to ask Dr. Mayo if in adherent ulcers of the posterior wall of the stomach he has noticed characteristic pain in the dorsal region, and whether this pain is not at times also referred to the precordial region? In a recent case of my own this symptom was characteristic. I would also like to call attention to the fact that in about 58 per cent. of all cases of fatal hemorrhage from the stomach, the hemorrhage comes from the splenic artery through ulceration. The splenic artery at times does not run along the upper border of the pancreas, as is described in the text-books, but within the upper part of the pancreas itself. I have seen a fatal hemorrhage from ulceration of the splenic artery in this situation, and so can speak for the truth of it. In the loosening of these adherent ulcers of the posterior wall of the stomach great gentleness should be exercised; even one might possibly, in the upper part of the pancreas, meet with the splenic artery and bring about a fatal termination through rupture and subsequent hemorrhage.

Dr. E. Wyllys Andrews, Chicago.

Dr. Mayo's paper suggests a possible swinging of the pendulum back to the time of the German surgical congress of 1900, when so many of the men brought out their new work on the direct treatment of gastric ulcer, especially for hemorrhage. Leube and others at that time were advocating the direct treatment by cautery, by excision, and by sometimes ligating the vessel *in situ*. Then the pendulum swung away from the direct interference, from intragastric operations. Again we seem to be moving a little backward in the direction of the direct treatment of ulcers.

At that time it occurred in my practice that I was obliged to treat two very bad cases by emergency operations for violent bleeding: in both I found the ulcer so situated that excision was impracticable after a gastrostomy. In the first case tentatively, and in the second intentionally, I tied the ulcer by ligation *en masse* of a cone of tissue

of stomach wall internally. This operation was later published by one or two English surgeons, Moullin, and others. After doing this I was anxious for a few days, thinking the necrotic cone of tissue ligated off would be digested by the stomach juices before firm union could take place and establish a retroperitoneal fistula, which would be worse if possible than perforation intraperitoneally. I then made a series of experiments to determine the length of time in dog and cat that such a cone of tissue would remain. Our experiments proved that in dogs the mass of tissue would not hold the ligature longer than forty-eight hours. Each case, of a dog, killed in three days, showed it about to break loose. We established to our own satisfaction that when a cone of tissue is ligatured inside the stomach, it is absolutely essential to reinforce it by a suture from the outer wall of the stomach by inverted or other stitch to prevent perforation and leakage.

Dr. Carl A. Hamann, Cleveland.

In a very limited experience in gastric surgery I have, on two occasions, had to resort to pylorectomy after gastro-enterostomy for duodenal ulcer because of hemorrhage following several months after the original operation, the ulcer, of course, not having healed. I would like to hear Dr. Mayo's experience in such matters.

Dr. Mayo. In regard to Dr. Summer's question, I am sure that cases of deep gastric ulcer excavations into the pancreas do have dorsal pain extending to the left anteriorly in the situation of the body and tail of the pancreas, and it is frequently hard to relieve this even by morphine. One might not suspect, therefore, any trouble with the stomach because of the nature and situation of this pain on the left side going into the back.

In two cases we have practised successfully Andrews' method for checking acute gastric hemorrhage, and what he says in regard to the necessity of covering the internal mucous suture with sutures outside in the peritoneal coat is, I believe, correct. Dr. Armstrong called my attention to the following fact: I was speaking of cases of acute gastric hemorrhage in which we had not succeeded in checking the oozing of blood from a large gastric erosion. He told me of several such cases he had operated, using the Paquelin cautery at a black heat, and passed it over extensive mucous surface erosions, and that it stopped the hemorrhage; the patients got well and have had no complaint following the treatment.

In regard to the necessity of excision of ulcers, I agree with Andrews that excision is the proper thing where possible because of cancer liability. There is no getting away from the fact that chronic irri-

tation has something to do with the production of cancer. Bloodgood and Keen have shown that cancer of the skin always develops upon some previous lesion, and I think it will be shown that the internal surfaces of the body also present some form of lesion which enables cancer to develop. In a very high percentage of cases of cancer of the stomach which we have seen sufficiently early to excise, the pathologists have shown that the cancer developed on an old gastric ulcer. This does not apply to ulcers in the duodenum, as here ulcers seldom seem to undergo cancerous degeneration.

SOME MODIFICATIONS OF TECHNIQUE IN THE SURGERY OF THE GALL-BLADDER AND BILE DUCTS.

By JOHN E. SUMMERS, M.D.,
OMAHA, NEBRASKA.

Experience to date has developed successful lines of surgical procedure in the operative technique of cholecystostomy, cholecystectomy, choledochotomy, cholecystenterostomy, and several rare operations upon the gall tracts. In my judgment, when the most reliable life-saving operations are to be chosen, sufficient importance has not been placed upon (1) the condition of the patient at the time of operation, (2) the local findings after the abdominal incision has been made. The writer published eleven years ago, in the *Philadelphia Medical Journal*, a technique for cholecystostomy which had in principle the formation of a channel for drainage, lined by peritoneum (a continuous peritoneal drainage route). For several years prior to this publication I had found, by following out this principle, that the danger of a fistula was avoided in all cases when the route to the duodenum via the cystic and common bile ducts was free. Formerly it was not an infrequent experience that, like an intestinal fistula, the mucosa of the gall-bladder became attached to the abdominal incision, like the mucosa of the intestine, so as to cause a fistula.

The technique which I published and illustrated in 1900 is that generally advised by text-book writers; some few modifications have been made: The Drs. Mayo, in Keen's *Surgery*, vol. iii, p. 1017, illustrate and describe my technique, as modified by a purse-string suture. The original technique is well illus-

trated in Jacobson and Rowland's *The Operations of Surgery*, vol. ii, and also by Binnie. I call attention to this technique because it is the one in use today by most surgeons, but too few seem to realize its limitations; at least, their writings and my observation of their work have so impressed me. There are contraindications to the attempted employment of the usual technique of cholecystostomy, when from the situation or size of the gall-bladder it is impossible to sew it to the parietal peritoneum without loosening the parietal peritoneum on each side of the abdominal incision, so that these flaps of peritoneum can be depressed and attached to the gall-bladder. This loosening of peritoneal flaps (introduced by Mayo Robson) although in some cases practicable, is *never* a wise procedure, because it results in the formation of painful and maybe dangerous adhesions; it is entirely unnecessary. If the drainage tube is properly fastened into the gall-bladder, nature in a few hours protects the tract of the drainage tube by limiting adhesions. A cigarette drain may be employed to still further establish a protective route for the drainage tube.

Whenever the gall-bladder is infiltrated so that a safe and easy invagination of its walls is difficult, no attempt in this direction should be made. Many surgeons under such circumstances sew a drainage tube into the gall-bladder, and then sew the gall-bladder to the peritoneum of the abdominal incision. There is danger that a fistula may follow this technique. I have seen such results. My practice is, first, to excise the mucosa of the gall-bladder for one-half to three-fourths of a centimeter around the periphery of my incision into it, and then fasten the drainage tube by a securely tied purse-string catgut suture, introduced so as to exert sufficient pressure upon the mucosa beyond its excised border; this not only secures the tube and prevents hemorrhage, but also eliminates the mucosa in such a way as to prevent the formation of a fistula.

When infection is a marked feature of the contents of a gall-bladder, and its walls are thickened and edematous, none of the methods of technique already described are suitable or safe.

The object of treatment in such an instance is to provide drainage with the least trauma to the integrity of the gall-bladder walls; more especially to the mucosa, which may in greater or lesser part be necrotic. Whenever possible, the soft adhesions surrounding such a gall-bladder should not be disturbed—rather, one or more gauze strips may be introduced to still further insure the localization of the infection. The gall-bladder must be freely incised, and, if easily done without tension, sewed to the abdominal incision and drained with a tube. If tension would follow such suturing, introduce and fasten by a suture a good-sized rubber tube into the gall-bladder, and by cigarette drains and gauze strips completely circumscribe the infected gall-bladder.

In the absence of infection cholecystectomy is a justifiable operation. An old contracted gall-bladder containing a calculus *may* better be removed. Hydrops of the gall-bladder from an impacted calculus in the cystic duct or a stricture closure of the cystic duct may be best treated by cholecystectomy, compensation by hypertrophy of their walls and enlargement of their lumen having taken place in the hepatic and common ducts. However, I must take issue with those who advise cholecystectomy in any acute infection within the gall-bladder, extending into or beyond the cystic duct. Likewise, I feel confident that more lives will be saved and fewer complications follow by avoiding cholecystectomy when infective inflammations are apparently confined to the gall-bladder, especially so should there be gangrene of the gall-bladder.

All acute infections of the gall-bladder, empyema, gangrene, either involving the mucosa alone or the muscular walls and peritoneum, should be treated by simple incision and drainage after a protective gauze packing-off of the peritoneal cavity. I have known disaster follow cholecystectomy in such cases—the crushing of the cystic duct and its artery, more especially of the poison-laden lymphatics; the trauma to the peritoneum passing from the gall-bladder neck to the gastrohepatic omentum can, and does in some such instances, lead to a thrombophlebitis and

fatal infections. In 2 cases I know of there was sloughing of the stump of the cystic duct, destroying it so that the biliary fistula resulting communicated directly with the hepatic duct. Had the operative interference been limited to free incision into the gall-bladder after gauze packing, the gangrene would probably not have extended; tension would have been relieved, and had not nature brought about a cure, the patient's improved general condition would have admitted of some one of the several plastic procedures being carried out. The removal of gallstones from an infected gall-bladder should be done with great gentleness; in fact, at times it is much wiser not to attempt their removal until the circulation is better established by the relief of tension following free incision of the gall-bladder fundus. The spooning out of gallstones is always accompanied by more or less trauma to the mucosa of the gall-bladder, thereby, in seriously infected patients, opening up fresh foci for attack by the invading germs. The expression of enough of the stones through a free incision into the gall-bladder fundus by passing the fingers of one hand under the gall-bladder and raising it up against the under surface of the liver or against the fingers of the other hand, as indicated, will limit trauma, reduce tension, and admit of temporary drainage. In these instances, if the common duct is enlarged considerably and the gallstone history of relatively long standing, this enlargement may not be a compensatory change, but one due to an impacted stone in the lower end of the common duct, and this duct should be incised and drained. I have the notes of a number of patients teaching the wisdom of the practice advised, and I have seen death follow the more ideal technique. One particular fact has been impressed upon me: Whenever, upon incising an infected gall-bladder of a very ill patient, there is a foul odor to its discharging contents, no further trauma should be inflicted within the gall-bladder. If in such a case it is possible to reach the cystic duct, it should be incised. Open drainage and protective gauze packing are the best life-saving measures; these are emergency operations, and it is wonderful how seldom secondary operations are required.

Years ago, in an emergency, I made an anastomosis between the common bile duct and the duodenum; there was a stricture of the cystic duct and also of the duodenal end of the common duct. The patient recovered. (*Journal of the American Medical Association*, March 10, 1900.)

The anastomosis of the gall-bladder to the duodenum or other parts of the bowel is usually readily feasible, and valuable in obstructions in the common duct and in chronic pancreatitis. Its exact position in the latter condition is not determined, but I am personally convinced of its value. If the temporary drainage of cholecystostomy is of value in the treatment of chronic pancreatitis, then the permanent drainage by cholecystenterostomy must be doubly so. When cholelithiasis is a complication of pancreatitis the drainage should always be external, and possibly will be favored by the repeated forcing of water through the ducts into the duodenum, as recommended by McArthur. Likewise, such treatment, cholecystostomy and duct washings, may be advisable whenever cholecystitis is a prominent symptom as a complicating or relapsing factor of typhoid fever. This surgical procedure should only be employed after the failure of vaccines. New infections may occur through the nurse taking care of typhoid patients not using proper "surgical" precautions, as the wearing of rubber gloves, etc. "The route from the bedpan and urinal to the food tray is a short one." I have had made for me, and used, horse serum, each 10 c.c. containing 10 grains of calcium lactate, which I believe has been, as a prophylactic measure, of service in preventing possible hemorrhage in cholemic cases.

DISCUSSION.

Dr. Lewis L. McArthur, Chicago.

I want particularly to urge the slight interference which Dr. Summers recommends in the acute septic gall-bladders. Certainly so much better after-results are obtained that it should appeal to everyone, and if necessary a secondary operation can be performed, where no opportunity would exist for a second operation were such methods not followed out. Again, the utilization of the bile tract, which has been opened and drained for the purpose of relieving the kidney of cholemic sepsis and those other sepses dependent upon long-continued biliary trouble, has proved in my hands of so great value that I want to urge those who have not tried it to do so. I would like to mention also a little fact to facilitate the use of flushing, particularly in those cases in which the common duct is being drained. That is, to insert the drainage tube into the common duct an inch or so downward, instead of, as heretofore practised, upward toward the liver. With the tube inserted in this way an ordinary ureteral catheter can then be passed through the drain into the common duct, and will find its way readily into the duodenum. Once there, one can use the direct method of irrigation of the small intestines much as one can use the appendix for the large intestine. Through this fistulous tract, too, I have been able to sustain weakened patients, just as one does through a jejunostomy, by giving them sufficient carbohydrates in the form of dextrose in salt solution to afford nourishment.

Dr. Charles H. Mayo, Rochester, Minn.

Dr. Summers has certainly been instrumental in the advance of surgery of the gall-bladder in America. He was the first surgeon to turn in the peritoneal surfaces of the gall-bladder, and from that time the old fistulas which used to follow drainage of the gall-bladder ceased.

We can subscribe to practically all the statements he has made in regard to the necessity for the careful treatment of the mucosa in the septic cases, and we have also seen great benefit derived from the use of salt solution washing through the cystic and common ducts into the intestine after McArthur's plan. The patients often wonder where the salty taste in their mouth comes from.

CHRONIC COLITIS AND PERICOLITIS.

By ARPAD G. GERSTER, M.D.
NEW YORK.

Bacterial infection of the peritoneum, either by direct surface contact or from within the visceral lumina by exosmosis through their walls, leads to denudation of endothelial covering, which results in adhesion of adjacent surfaces. The solidity and density of the adhesion seem to depend as much upon the duration as upon the intensity of the infective process. Chronic ulceration, such as for instance that caused by a foreign body in the appendix, may produce the most dense and massive deposit of newly formed connective tissue. Naturally, the deposit is densest in the immediate vicinity of the inflammatory focus, diminishing in proportion to distance. In the case of adhesions due to bacterial infection, the principle "*cessante causa, cessat effectus*," obtains in the most eminent way. Experience on the operating table and in the autopsy room has furnished abundant proof of the truth of this fact, for extensive, dense adhesions which had been demonstrated at a previous operation were often found entirely absent at a subsequent operation or autopsy.

The modus of absorption and disappearance of adhesions is, strictly speaking, a physiological process, parallel to the embryonic processes of the formation of saccular cavities lined with endothelium, such as the joints, the bursæ, the sheaths of the tendons, the pericardium, pleura, and peritoneum. Its factors are absorption, dehiscence, and locomotion; the last factor mainly derived from the friction of adjacent tissue planes.

The form of adhesions observed in certain cases of chronic

enterocolitis is so different from that just described, that in their case the use of the unqualified term "adhesions" is unfortunate, because misleading. While true adhesions involve at least the serosa, which is replaced by dense, more or less organized connective tissue which often extends to the muscularis and mucosa, causing absolute fixation of the adjacent segments, the other so-called adhesions do not enter into a close organic union, even with the serous coating of the gut. They can be stripped off without difficulty, and, after their removal, the intact, glistening serous coat of the intestine is exposed. True, they do adhere, but in a very loose manner.

While dense adhesions may form between any two or more parts of the peritoneum, usually in close proximity to a destructive lesion, these veil- or cobweb-like new formations have a typical site. They are invariably found on the lateral aspect of the cecum, of the ascending and descending colon, or of the sigmoid flexure, beginning in the parietal peritoneum and radiating inward over the anterior aspect of the gut. The term "radiating" is peculiarly expressive, because their general arrangement is fan-shaped. Their attachment to the parietal peritoneum evidently represents the oldest part of the growth. This is attested by the presence of a narrow, glistening, fibrous band of tissue, running parallel with the axis of the gut, which assumes a scalloped outline whenever the gut is pulled inward. This scalloping is produced by the fact that certain portions of the membrane are shorter than others, and that traction upon these shortened fibers accentuates this unevenness. We also find that these shorter strands are thicker and more massive than the rest of the membrane, so that when the gut is distended by gas they cause visible transverse indentations of lesser or greater depth, which often produce a considerable narrowing of the intestinal lumen. Their substance is a glossy, transparent, myxoma-like, almost colorless tissue, within which, from the base to the periphery, a well-defined system of ramifying minute vessels is seen extending transversely to the gut. This vascular system holds no relation with that of the surface of the gut, for, stripping

off causes no or at most minute hemorrhage. If any portion of the membrane, but especially one containing a restricting band is divided, a lozenge-shaped hiatus is immediately formed, and the correspondingly restricted area of the gut, being freed, unfolds. Transverse division of the entire "veil" consequently permits complete unfolding of the gut. Whether divided or excised, these membranes will invariably reform if their cause, the colitis, persists. Their most massive development takes place around the physiological points of relative narrowing of the gut, such as the cecum, the hepatic, sigmoid, and especially the splenic flexures. Habitual constipation arrests the progress of the intestinal contents. Should ulcerative processes supervene at these points, the membranous formation may become modified by more or less massive deposits of cicatricial tissue, representing close, true adhesions.

As attested by all authors beginning with Virchow, this process has a predilection for the vicinity of the splenic flexure, where, as Cannon has demonstrated in the cat, and Holzknecht and Bloch in the human being, several factors combine to cause an arrest of fecal transportation. First of all, the large gut is firmly attached here to the under surface of the diaphragm by the short phrenocolic ligament. This, the highest attachment of the colon, is the apex of a sharp bend, where portions of the transverse and descending colon for a distance of even six inches are normally found lying parallel to each other in close contact. At the bend itself a spur is invariably present. Its action as a valve depends upon the degree of its development, which is variable (Roith). According to Cannon, the purpose of this arrangement is to prevent the rapid entrance of fecal matter from the upper portions of the colon into the sigmoid. The function of the former is absorptive, of the latter, eliminative. Hence we find that ordinarily the cecum, ascending and transverse colon are distended with fecal matter and gas, while the sigmoid is empty and contracted.[1] A similar though less pronounced

[1] Otto Roith, "Die Füllungsverhälthisse des Dickdarms," etc., Anat. Hefte, I Abthlg., 1902, xx, 19.

arrangement exists at the hepatic flexure (Glénard). The resistance offered by the splenic flexure on one side, and by the closure of the ileo-cecal valve on the other, renders consecutive peristaltic and antiperistaltic locomotion of intestinal contents between these points possible. If, through certain influences, this normal or quasi-normal degree of retardation is exaggerated, undue desiccation will take place above the splenic flexure, and with this, at first occasional, later on frequent, finally, habitual constipation follows. With a preponderant meat diet, the nature of the bacterial flora of the cecum and colon are modified;[1] putrefactive processes then engender catarrhal changes in the mucosa, leading both to the penetration of the intestinal tissues by pathogenic micro-organisms, and to the absorption into the circulation of their products as well as those resulting from decomposition of food remnants and secretions.

This sequence of events is attested by the fact that in persons suffering from habitual constipation, overcopious meals containing much meat are followed by attacks of severe colic, mainly located in the region of the cecum, and relieved by abundant stools, containing both old, solid, and recently formed fecal matter. Very often these attacks of colic have a most alarming character, and hence are apt to lead to erroneous diagnoses and ill-advised operations. The chief location of the pain and of the resistance to touch simulating a solid tumor is in the cecal region. Under such circumstances, where a diagnosis of acute appendicitis is often made, operation has revealed a perfectly normal appendix and a greatly distended colon. After operation, attacks have continued to recur as before. In other instances where the appendix was found to be really diseased, its removal, nevertheless, did not free the patient from recurrent and violent attacks of cecal disorder. The explanation of this is, that the appendicitis was the secondary, though most pronounced and urgent part of the process, while its fundamental element was the colitis. The marked symptoms of the complicating appendi-

[1] Carrière, Report in Schmidt's Jahrb., 1900, vol. cclxvi; and Rolly, Deut. med. Woch., 1906, No. 43.

citis overshadowed the underlying colitis, which consequently escaped attention. Therefore, it is not rare that the successful removal of a damaged appendix is not followed by complete and lasting cure, and more or less prolonged periods of temporary relief are obtained only by means of careful and continuous regulation of the intestinal function by diet, enemata, and laxatives.

The symptomatic preëminence of the cecum and ascending colon is based on certain anatomical peculiarities of this part of the large intestine. First, it normally represents its widest and most distensible portion. This distensibility is the direct outcome of the fact that its muscular layer is thinner and weaker than that of any other part of the large intestine. Furthermore, being the chief seat of bacterial proliferation, it is also the chief seat of catarrhal disturbances and of gaseous production. The final outcome of these factors is habitual distension and atony (typhlatony).

Wilms[1] found in a considerable number of cases that symptoms of chronic appendicitis were simulated by cecal processes which, in his opinion, were due to great laxity of the attachments of the caput coli. To this abnormal mobility he attributed an impeding effect upon cecal evacuation, which in its turn was responsible for recurrent attacks of cecal colic. The symptom complex of this condition consisted in the periodic appearance of a palpable, painful tumor in the right iliac fossa, with simultaneous recurrence, in the habitually constipated patients, and of violent attacks of colic centred about the cecum, the trouble being relieved by one or more copious evacuations of feces and gas.[2]

[1] "Das Caecum Mobile," etc., Deutsch. med. Wochenschr., 1908, No. 41, and "Fixation der Caecum mobile bei Fallen von sogen. chron. Appendicitis," Zentralbl. f. Chir., 1908, No. 37.

[2] In a recent publication of great interest ("Schmerzempfindungen innerhalb der Bauchöhle," etc., Med Klin., January, 1911), dealing with the significance of pain in the abdominal cavity, Wilms refers to the regular presence of pseudoperitoneal veil-like "adhesions" about the cecum mobile, characterizing the pains as "Adhesions beschwerden." This is, however, only a seeming paradox.

The correctness of Wilms' views seems to be supported by the evidence of his experience with colopexy upon so-called cecum mobile in 43 cases.[1] Of these, 75 per cent. were cured, 16 per cent. improved, and 9 per cent. remained unimproved.

That the element of excessive mobility alone is not adequate to explain the symptoms of Wilms' so-called cecum mobile seems to be admitted by the reasonings contained in the excellent article of his assistant Stierlin[2] on the same subject. This author concedes that mobility of the cecum was observed in from 10 to 23 per cent. of a series of cadavers in which all evidence of intestinal trouble was lacking. A number of years ago both Wandel and Curschmann called attention to the frequency of a long attachment of the cecum, a condition that in itself is symptomless and may accidentally be found at autopsy.

Habitual constipation is an indispensable factor, a factor which will determine attacks similar to, if not identical with, those of Wilms' cecum mobile syndrome and this in cases (my own observation) where the attachments of the cecum were not only not too long, but where the cecum was actually bound down by true adhesions. It may be readily admitted that undue mobility, by facilitating distension through lack of support and by exaggerating the effect of compression by bands, can increase resistance to the expulsive efforts of the cecum. The presence of these factors undoubtedly aggravates the pain of colic here.

The question of the first cause of the trouble is still undecided. A congenital redundancy of the large gut is undoubtedly a predisposing element, but it seems that in the majority of cases the resultants of an improper way of living constitute the evident cause. These comprise not only habitual errors of physical hygiene, of which those of diet hold the foremost rank, but also faults of mental and moral régime, the emotions, through the glandular secretions, having a most important influence upon the processes of digestion, absorption, and assimilation.

[1] "Das Caecum mobile als Ursache, etc., und die Erfolge der Colopexie," Deutsch. Zeitschr. f. Chir., Band, 106, p. 474.

[2] Loc. cit., p. 413.

The well-known vicious circle of enteroptosis, chronic colitis, autointoxication, and neurasthenia need not be dwelt upon here. It may suffice to say that in many cases where there is no hereditary taint an acquired neurasthenia of intestinal origin may be improved, if not cured, by proper measures.

Though the common forms of chronic colitis will in most instances lead only to the formation of the pannus-like pericolitic membranes above described, in rare instances they may cause the development of intramural abscess of the intestinal wall, with or without perforation. Bittorf[1] quotes Lejars[2] and Donaldson,[3] who have encountered perisigmoidal abscesses at the operating table. He also mentions similar experiences of himself[4] and of Bäumler,[5] one of whom found a non-perforated intramural abscess of the cecum near the ileo-cecal valve, the other a similar abscess in the wall of the ascending colon. Both patients died of streptococcic peritonitis. In both of these cases the appendix was healthy. Bittorf[6] mentions, besides these, the case of Matthes, who, operating for presumed appendicitis, found the appendix normal, the sigmoid, however, intensely congested and thickly coated with a deposit of fibrin.

The peculiar parallelism of the transverse and descending colon near the splenic flexure and the sharp angle and spur formation there constitute favorable conditions for producing and maintaining constipation. The resulting chronic colitis may lead to production of copious pseudoperitoneal membranes. Where fecal retention has led to ulcerative processes of the mucosa, extensive firm adhesions between the parallel segments of the intestine may result.[7] This condition is so typical that the term "Doppelflintenstenose," double-barrel stenosis, has been suggested and accepted. Examples of this disorder are abundant

[1] Ueber Pericolitis, Mittl. a. d. Grenzgebieten, 1909, vol xx.
[2] Sem. Méd., 1907, No. 52.
[3] Brit. Med. Jour., 1907.
[4] Loc. cit., p. 163.
[5] Arch. f. klin. Med., 1902, lxxiii, 96.
[6] Loc. cit., p. 162.
[7] Analogous conditions have been observed at the hepatic flexure.

in American,[1] French, and German literature. Cases of Tixier, Terrier, Poirier, Legueu, Bérard, Quénu, Walther, Routier, and Bergmann are quoted in abstract by Braun,[2] while more recently both Payr[3] and Allard[4] have published very striking instances of this condition. They observed ulcerative changes and a complicated system of adhesions with stenosis at the splenic flexure and marked, often enormous distension of the transverse and ascending and an empty and shrunken state of the descending colon. A certain number of the patients were relieved by colocolostomy, ileosigmoidostomy, or by the establishment of an artificial anus.[5]

Conclusions. 1. The peritoneum reacts to the infectious processes ordinarily associated with chronic colitis by the formation of characteristic vascularized transparent membranes (pseudoperitoneum), which take their origin along the external lateral aspects of the cecum, ascending colon, and hepatic flexure on one side, and the sigmoid flexure, descending colon, and splenic flexure on the other. In a general way, this line of origin runs parallel with the long axis of the gut, and the tissues deposited along this line represent the oldest constituents of the membrane. The membrane extends transversely across the gut, and, often reaching to the inner reflection of the peritoneum, completely envelops the intestine in a system of fan-like, radiating bands, between which the thinner parts

[1] The article by J. N. Jackson (Surg., Gyn., and Obst., Sept. 1909, p. 278) is the most noteworthy American publication about pericolitis to date (May 1911).

[2] "Ueber den durch Lage und Gestaltsverand. des Colon bed. Darmverschl.," Deutsch. Zeitschr. f. Chir. vol. lxxvi, 555.

[3] Therap. Monatshefte, 1909, No. 23.

[4] Ueber gutartige Stenose an der Flexura coli sin, Med. Klinik., April, 1911.

[5] All the surgical measures, beginning from colopexy (Wilms), extending to colocolostomy, colosigmoidostomy, and culminating in Lane's heroic abolition of the entire large gut, are mere mechanical makeshifts, applied to correct the mechanical factor of the later and latest phases of long-neglected processes which might have been prevented by a timely dietary régime and the simplest medication. In verity, our triumphs in connecting and disconnecting tubes and receptacles are but a sort of glorified plumbing.

of the membrane are outstretched like webs. Except at the flexures, constriction by one or more thickened bands of membrane is rarely marked enough to provoke ileus-like symptoms. However, flexion of a lax, unduly dilated, and abnormally movable portion of the gut upon the edge of such a strand may occasionally become the cause of serious trouble.

2. An eminently predisposing factor of chronic colitis is an undue accentuation of the physiological apparatus, serving to retard fecal transportation. This refers mainly to the arrangement of the splenic and, in a lesser degree, of the hepatic and sigmoid flexures. Congenital or acquired laxity of attachment, and congenital or acquired redundancy of diameter or of length of certain portions of the large intestine, may both be strongly predisposing and seriously aggravating factors in the development and course of the disease.

3. Prevention has a wide field of usefulness, especially here in America, where chronic colitis is almost endemic. A reasonable restriction of animal food will control putrefactive processes; a generous and daily use of fresh vegetable matter, in the shape of well-cooked and attractively seasoned dishes, will supply the bulk and friction needed to induce normal and adequate peristalsis. The practice of what may be called "physiological intestinal discipline" should be inculcated from infancy, and should become as much a part of personal hygiene as are ablutions and baths.[1]

4. The graver aspects of the malady usually demand surgical intervention, but here, too, good results follow only if dietary and general hygienic measures are subsequently instituted and consistently practised.

Histories. To illustrate the condition, I present herewith extracts from the histories of five typical cases observed in my wards between November 10, 1910, and April 12, 1911.

[1] The prolonged use of daily small doses (1 teaspoonful) of castor oil, taken before breakfast, combined with a diet suitably adapted to each case, will cure or at least control many cases of early and not too aggravated chronic colitis. Buttermilk is an admirable adjuvant.

Case I (Surg. No. 118.784).—J. W., aged thirty-five years, tailor, Russian. Admitted November 10, 1910.

He had been more or less constipated since early boyhood; for the past eighteen months attacks of obstinate constipation had become more and more severe; these attacks ended in severe general colicky pain, which became most marked in the ileocecal region. During each one of these attacks a painful and hard tumor was observed in the iliac fossa; this softened after the cessation of the paroxysm, but did not disappear. The paroxysms continued at short intervals until copious evacuations of hard, later soft, feces ended the attack. A mucoid, slightly bloody diarrhea (10 to 15 stools per day) then followed for three or four days, gradually diminishing until constipation again set in. Considerable loss of flesh and strength.

Status Præsens. A fairly nourished, somewhat anemic man. Lungs, heart, and the large glands were normal. The abdomen was soft and flat, except in the right iliac fossa, where a tympanic, tender, soft tumor was felt, which became rigid and painful under repeated palpation. The pain was colicky and ended coincidently with the termination of erectile effort of the mass, which evidently consisted of the cecum and the lower portion of the ascending colon. The tumor was laterally movable to a moderate extent, and presented a roughly cylindrical outline which, however, varied both in size and contour during the different fits of pain. Under all circumstances a hard, cord-like projection could be felt extending downward from its lower pole; this, unlike the rest of the mass, remained sensitive to pressure during the intervals of intestinal repose. There were moderate elevations of temperature. Urinary findings were negative.

Diagnosis. Chronic colitis, with chronic stenosis of hepatic flexure; possible inflammatory tumor of ileocecal region, or chronic appendicitis. A neoplasm was excluded.

November 15. Laparotomy through right rectus; incision was made 4 inches long, to permit of an adequate examination. The cecum and ascending colon were much dilated by gas and

feces; their walls were somewhat congested and thickened. A thick, solid band was seen extending from the parietes downward and inward to the hepatic flexure, crossing it and forming a pronounced point of obstruction (Fig. 1). Considerable manual pressure was needed to propel gas past this point. The thickest portion of this membrane was divided by a transverse incision, whereupon the gases in the cecum immediately escaped

FIG. 1.—Case I, schematic. All the diagrams were made by the author in the operating room directly after operation.

into the transverse colon. The site of the incision assumed the shape of a lozenge, the longer sides of which (lying crosswise to the longitudinal axis of the gut) were united by a few catgut stitches. A similar membrane of lesser size, involving the ascending colon, was likewise dealt with. The caput coli and appendix were thickly enveloped in an extensive arrangement of pseudomembrane. From this the thickened and congested appendix,

which was bent upon itself, was easily shelled out, ligated, and amputated. This evidently was the hard body felt before operation at the lower end of the mass. The membrane around the cecum was transversely divided and longitudinally sutured, as done before at the hepatic flexure. Layer suture of abdominal wound. Uneventful recovery. Discharged November 27, 1910.

In May, 1911, the patient presented himself, complaining of recurrent mild attacks of pain in the right iliac fossa. He had gained flesh, but was becoming constipated again. In the absence of the "air cushion symptom," and of erectile spasms, he was dissuaded from operation which he desired. He was further advised to resume the dietary régime previously followed, which he had lately neglected to observe.

Epicrisis. Though the local and most conspicuous symptoms disappeared for a while, the chronic colitis remained uncured and required attention. The appendicitis here was undoubtedly secondary to the long-standing colitis. It would be absurd to expect that removal of a diseased appendix could cure a colitis; yet this was and still is taught by a number of surgeons.

Case II (Surg. No. 119,425).—H. T., aged thirty years, clerk, Austrian. Admitted December 12, 1910.

Bowels constipated for several years past; chronic cough for four months; no hemoptysis, expectoration, or night sweats. No loss of weight. Five months ago he had an attack of violent abdominal pain (his first) lasting two days and relieved by catharsis. Since then (three weeks) repeated attacks of similar character set in; the first one was relieved by a laxative, the later ones recurred, although the bowels were kept open. No blood in stools, no urinary symptoms.

Status Præsens. General condition excellent. Physical examination revealed no abnormality except in the abdomen, where a movable, soft, tympanitic tumor was seen and felt in the right iliac fossa. This, on prolonged palpation, presented striking signs of intestinal erection with moderate colicky pain. Between spasms, slight pain on palpation was present all over the cecum. No fever.

Diagnosis. Chronic colitis; chronic stenosis of hepatic flexure. The question of appendicitis was left open, since no definite appendicular signs were present.

December 15. Laparotomy; Kammerer's incision, four inches long. The ascending colon was distended and bound to the parietes by two systems of pseudoperitoneal membrane; an upper aggregation, consisting of two bundles, which were rather

FIG. 2.—Case II, schematic.

massive and firm, constricted the hepatic flexure. Lower down another fan-like membrane compressed the middle portion of the ascending colon, causing a deep indentation there. Below the caput coli a stout, glistening mass ascended from the pelvic parietes and bifurcated about an inch from the cecum (Fig. 2). A mesial branch spread over the tænia coli and a lateral one extended over the external portion of the cecum. Between these

two bands was an open falciform pocket into which the finger could be introduced for an inch and one-half. Slight pressure caused the sudden protrusion of the apex and distal two inches of a normal looking appendix. The base of the appendix was covered by membranous material, which was easily wiped off. All the bands just described were divided wherever they diminished the lumen of the gut. Those around the appendix were removed, together with that organ, which was found absolutely sound. The wound was closed completely. Uneventful recovery. Cessation of all colicky symptoms. Discharged January 1, 1911.

Epicrisis. Though the duration of the disorder was not as long as that of the previous case, the anatomical changes and symptoms were of a pronounced character. The lesser intensity of the pain might be explained by the absence of congestion of the cecum and ascending colon. The lack of marked inflammatory changes here was assumed to indicate a colitis of rather benign type. The absence of fever and the good condition of the patient confirmed this view. And yet, with a mild colitis, there was a prodigious development of pseudoperitoneal membrane, the expression of an advancing proliferation, a process, which had begun to evoke stenosis and intestinal erection, and which must be ascribed to irritation by materials absorbed from the interior of the intestine. These facts suggest that the peritoneum reacts in one way to concentrated toxins from an acute bacterial invasion and in another way to the toxic substances derived from putrefying intestinal contents. Combined forms of these two processes must, of course, be very common, and tend to confuse matters.

Case III (Surg. No. 119,732).—R. G., aged twenty years, bookkeeper, born in United States. Admitted December 29, 1910.

She had been constipated for several years, and had suffered from periodical attacks of sharp bellyache, relieved by laxatives. Menses normal. Continuous dull, aching pain in right flank for some time. Two days previously diffuse colicky pains set in all

over abdomen; she vomited four times. The following day the pain became excruciating and most marked in the right iliac fossa. She vomited again.

On admission, temperature 102° F.; pulse and respiration somewhat accelerated; anxious facial expression. Well nourished. Lungs, heart, and upper organs of abdomen negative; urine normal. Abdomen moderately distended; right rectus rigid, hence palpation unsatisfactory. No dulness over iliac fossa. Per rectum no mass can be felt, but right side of pelvis very painful to touch.

Diagnosis. Chronic colitis of old standing; recent appendicitis; the fever, local muscular rigidity, vomiting, together with the absence of an exudate, indicating an acute form without perforation.

December 29. Laparotomy. Kammerer's incision of three inches' length. The appendix was closely bound to the cecum by recent, firm, very vascular adhesions, blunt separation of which was difficult and caused copious oozing. Both the appendix and the adjacent parts of the cecum were intensely congested, thickened, and brittle.

In tying off the base of the appendix the ligature cut through the outer layers. Stump of appendicular mucosa was thoroughly charred with the actual cautery, then, depressed, was buried under two tiers of sutures. Examination of the appendix showed a tight stricture close to the line of section, beyond which it was distended by about one-half a dram of thick, odorless pus, *empyema*. The outer side of the ascending colon was invested by an extensive pseudoperitoneal membrane, originating, as usual, along the external line of reflection. It swept in a graceful curve downward toward the cecum, along the outer edge, of which it again became united with the parietal peritoneum (Fig. 3). A thickened, rib-like portion of this membrane suggested comparison with the rib and beard of a feathered plume. There was a noticeable constriction of the gut above the cecum. The membrane was easily separated from the colon, tied off, and removed. Cigarette drainage to appendicular stump and layer

suture of wound. The temperature immediately fell to 101.8° F., and steadily descended to the normal. Drain removed on third day; no suppuration. Discharged, healed, on January 13, 1911.

Epicrisis. The presence of the extensive and retracted membrane indicated that the colitis must have preceded the attack of acute appendicitis for some time; appendicitis masked the features of the colitis.

FIG. 3.—Case III, schematic.

CASE IV (Surg. No. 120,661).—S. K., aged twelve years, schoolgirl, Russian. Admitted February 12, 1911.

Two years previously she had been operated upon for appendicitis at another hospital. Remained at that institution nine days. Obstinate constipation, from which she had suffered before operation, persisted. The colicky pains and the tenderness in the right iliac fossa were absent for a little while after operation —that was for as long as she was kept on liquid and soft diet. There was occasional vomiting. Pains were worse at night, and especially bad after meals. No urinary disturbance. Menstruation had not set in.

Status Præsens. General condition fair. Choreiform movements of head, neck, and hands. Lungs negative. Systolic

cardiac murmur at apex. Abdomen slightly distended; a vertical scar in right iliac region; no hernia. In the right iliac fossa an elastic, non-movable, and tympanitic mass was felt. Pressure upon this was painful and elicited a succession of gurgling sounds. Pulse and temperature normal; urine normal.

Diagnosis. Chronic colitis with chronic stenosis of ascending colon or hepatic flexure.

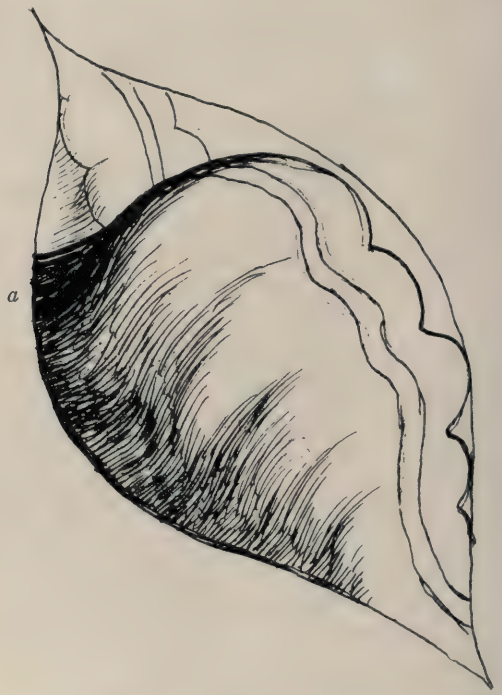

FIG. 4.—Case IV, schematic.

February 21. Laparotomy. Excision of the entire scar, which was not adherent to the cecum. Caput coli and about five inches of the ascending colon were closely invested by an extensive system of pale, translucent, and scantily vascularized peritoneal pseudomembrane. A tense, balloon-shaped dilatation, involving the cecum and lower part of the ascending colon, was evidently caused by a dense, thick band, visible in the upper angle

of the abdominal incision (Fig. 4, *a*). This edge was the thickest part of a membrane, such as we have previously described. The bulging, distended portion below and the shrunken and empty segment of the gut above the line of constriction presented a striking contrast. The empty gut above became visible only when the overlapping, dilated portion below was pulled aside. Complete section of the membrane, including its thickened upper margin, was carried along the outer line of reflection of the gut, and effected a complete liberation of cecum and colon. The stump of the appendix, which had been removed at a previous operation, presented nothing unusual. Closure of abdominal wound. Uneventful, rapid recovery, with cessation of the previous symptoms, which had furnished the indication for the present operation.

The patient was instructed to observe a strict diet and to use castor oil in small doses for a long time. Discharged February 25.

Epicrisis. The short convalescence after the first operation and the small scar permit the inference that the appendix could not have been the seat of a very severe inflammation. Colitis had evidently preceded the appendicitis. After all, was there any appendicitis?

Case V (Surg. No. 121,594).—A. H., aged thirty-six years, fur cutter, Roumanian. Admitted March 31, 1911.

Habitual and obstinate constipation of many years' standing. During the past two years there were twelve attacks of colicky pain, principally centred in the iliac fossa. Three days before admission the present attack began with indefinite pains, both in the right iliac and the left lumbar regions. There was nausea with much belching.

Status Præsens. A violent attack of colic, lasting about one hour, occurred shortly after admission. There was nausea and sweating, but no fever. Tension of the right rectus was variable; it disappeared with cessation of colic. A tympanitic, tender, elastic swelling in the right iliac fossa emitted gurgling sounds on pressure.

Diagnosis. Chronic colitis with stenosis of the ascending colon; a possible chronic appendicitis.

March 31. Laparotomy by the house surgeon, Dr. Greenberg, disclosed a membrane extending from the right lateral parietal peritoneum across the cecum and ascending colon. Its most massive portion involved the hepatic flexure. The pale appendix, which was not adherent, was 5 inches long. It was removed, and examination of its interior showed nothing abnormal. The membrane was left intact and the abdomen was closed. Uneventful recovery. Patient was discharged April 12, with directions as to diet and régime. He was requested to report from time to time, so that the effect of simple removal of the appendix might be studied.

Epicrisis. This was another case in which colicky attacks due to chronic stenosis might have induced a superficial observer to diagnosticate appendicitis, or that phantom, appendicular colic. It will be interesting to see in this case whether the removal of a practically normal appendix will or will not cure a chronic colitis. The simple excision of an obliterating or obliterated appendix has been credited with such a marvellous efficacy in curing almost all ills of the gastro-enteric tract *by reflex action* that a critical revision of accepted opinions might well repay the trouble. It is held that minute changes in an appendix, many of them suggested or rather dictated by enthusiastic surgeons to the minds of complacent and accommodating pathologists, provoke by reflex action "hyperacidity, pylorospasm, true pyloric stenosis, cardiospasm, acute and chronic colitis, and even chronic pancreatitis with jaundice, cholecystitis, and cholelithiasis." The appendix, in short, has become a sort of biblical black sheep, which can conveniently be charged with as many unexplained ills of the human fabric as were formerly the uterine appendages. (The superior convenience of the appendix for this purpose is evident, since it is owned by both sexes.)

The marvellous cures of remote disorders ascribed to the removal of appendices, showing chronic or obliterating changes,

should be accepted on better warranty than that offered by the argument *post hoc, ergo propter hoc*. Is it not possible that the preparation for and the régime following laparotomy is in many cases the first serious and real regulation not only of the diet, but of the entire trend of a heretofore perverse and irrational course of life, and this notwithstanding the fact that such patients may have been surrounded for years by the solicitous care of "eminent specialists"?

DISCUSSION.

Dr. John F. Binnie, Kansas City, Mo.

The subject just brought up is one which has been of great interest to me for a good many years; I published something on it in 1905. To our knowledge of the toxic origin of this trouble I may possibly be able to contribute something by describing one case observed. A boy was brought to me a few years ago suffering from pericolitis and neurasthenia, with much emaciation. He thoroughly enjoyed ill health. He knew all the purgatives he could take, what articles of diet, every sort of pain that a neurasthenic should know, and his mother's apron strings were close to his hand. I found a condition much as described by Dr. Gerster, but the boy was in such extremely bad shape that I had to do a palliative operation entirely. I did a cecostomy. The result was that the boy was brought into good health in the course of weeks. He began speaking about joining the baseball team. His mother's apron strings lost their charm. When we stopped washing out the large intestine he began again to take an interest in the apron strings. That experiment continued for a year, then I did an ileosigmoidostomy. He is now playing football, and is a husky fellow who cares nothing about his diet so long as it is good and in sufficient quantity.

With regard to the causation of some of these things. Quite recently I made the diagnosis in three cases of Lane's kink, but in none of them was the real Lane kink present. Lane's kink is a deposit of scar tissue on the mesentery of the ileum close to the ileocolic valve, by which the ileum is immobilized by being pulled upward. In all three cases there was a sickle-shaped band of peritoneum passing down into the pelvis, without the slightest evidence of inflammation or any conditions such as Dr. Gerster mentioned. A picture may be found in Zuckerkandl's *Anatomy* of such an abnormal band of peritoneum immobilizing the last part of the ileum. In one case, that of a young lady, it was all that was present, although a diagnosis of appendicitis was made, and the condition was apparently cured by division of the band. In two other cases, one in the practice of my friend Dr. Jackson, there were present also many of the lesions mentioned by Dr. Gerster. I believe that the partial and intermittent obstruction to the bowels was the cause of trouble in these cases.

Dr. Gerster. There is only one feature I should like to cite, that in dealing with these peculiar forms of newgrowth, if I may so call

it, I have tried a number of the various well-known surgical procedures, such as the division of such a band as mentioned by Dr. Binnie. I found that the patient returned to the hospital with the same complaint two or three months later, with a band in the same locality. Therefore, having ascertained that the simple division was useless, I then did a plastic operation. I divided the band transversely and united it longitudinally. I found in these cases that that portion of the velum which had been treated in this way did not retract, but another portion retracted. Total excision yielded no better results. I have come to the conclusion that it is a condition in which plastic measures of any sort will be of no durable advantage. If you resort to a major operation, such as Dr. Binnie mentions, that will do some good, as doubtless would the removal of the intestine; but to this I never could make up my mind, because I believe that the large intestine is an integral part of the human economy.

THE TRIUMPH OF AMERICAN MEDICINE IN THE CONSTRUCTION OF THE PANAMA CANAL.

By J. EWING MEARS, M.D., LL.D.,
PHILADELPHIA.

In a paper published in the volume of TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION for 1908, entitled "Modern Medicine and Surgery in the Orient," I discussed the subject of the conservation of the public health, and directed attention to the methods of sanitation practised in the countries of the Orient, as I had observed them in a visit which I had recently made to these countries. In concluding the paper, I spoke of what had been accomplished in our country, and referred to the great work done in the Isthmian Canal Zone by Col. W. C. Gorgas, U. S. A., Chief Sanitary Officer, Isthmian Canal Commission, and stated that his achievements had made the construction of the Canal possible, claiming that its completion would be a triumph of American Medicine.

During the past winter I visited the Canal Zone and had, through the courtesy of Col. Gorgas, an opportunity to observe the marvellous results obtained in the conservation of the health, by the methods of sanitation employed, of the large army of officials and work people, some 47,000 in number, engaged in the stupendous undertaking of the Canal construction.

In order to fully appreciate what has been accomplished by the system of sanitation inaugurated by Col. Gorgas and so perfectly conducted by him and his able corps of assistants, it is necessary to consider the conditions of health which, up to the beginning of the work of the Americans, prevailed in the cities of Colon and Panama, and in what is now known as the Canal Zone, ten miles of territory acquired by purchase by the United States Government

from the Republic of Panama, and which is located five miles on either side of the Canal route, including an area of three hundred and twenty-two square miles.

For nearly four hundred years that portion of the neck of land between the Continents of North and South America, now called the Isthmus of Panama, has been known to be one of the unhealthiest regions of the Globe. Uninhabitable to any but the few natives who made their homes there, and the residents of the

Old yellow fever ward at Ancon Hospital.

cities of Panama and Chagres, at the mouth of the Chagres River, on the Atlantic Ocean, with their blood charged to the full with malarial parasites, who fell in great numbers victims to the deadly scourges of malarial and yellow fever, known in their most pernicious forms as Chagres fever, which, existing as endemic forms, frequently assumed the proportions of devastating epidemics, developing under the climatic conditions which encouraged the facile breeding of the anopheles mosquitoes, and the absence of any quarantine regulations which controlled the

influx of the stegomyia species, or of its work in transmitting infection.

The eager quest of gold in the waters and lands of California brought many white people to the Isthmus in the year 1849, who desired in this way to avoid the longer and much delayed route around Cape Horn. On foot, on mule, and in vehicles of varied design they fought their way through the almost impenetrable jungle, in torrid heat, under blistering sun-rays, and in torrential rains. Overcome by climatic conditions and exhausted by fatigue, they fell easy victims to the fierce onslaught of the native anopheles, which in swarming myriads welcomed the invasion of new blood. Many laid down to die to find an uninviting grave in the desolate morass and in the tangled jungle.

The tide of travel across the Isthmus increased to such extent as to encourage the building of a railroad from the Atlantic to the Pacific Ocean. This was undertaken in 1849 and completed in 1855, under very great difficulties in railway construction, owing to the conditions of land and soil. Here again the anopheles and stegomyia played havoc in the ranks of the laborers, and so many perished from disease that it became a common saying that every railroad tie represented the dead body of a workman.

Ignorant of the cause of malarial and yellow fevers and their methods of transmission, the medical officers in charge were forced to content themselves simply in combating the developed disease with antimalarial remedies and those commonly employed in treating yellow fever.

In the year 1881 another invasion of the Isthmus took place, when the original French Company began the construction of an Isthmian Canal. Eleven years—1881 to 1892—were consumed in construction work before the effort was abandoned, with very little accomplished comparatively in the way of a completed canal. While it is stated that corrupt methods and graft played an important part in producing the failure, it is believed that diseases, now preventable, were chiefly responsible. The fifty buildings devoted to hospital purposes left by the French bear testimony to the fact that the medical department was fully organized, but its work was largely ineffective, because the state of knowledge then existing was defective in producing information as to the pre-

vention of the diseases the medical officers were called upon to combat.

That heroic son of Medicine, Dr. Lazear, U. S. A., had not given his life to demonstrate that the infection of yellow fever was transmitted by the mosquito, Stegomyia fasciata, and Col. Gorgas, U. S. A., had not driven disease and pestilence out of Havana by the enlightened methods of sanitation devised by him. The hopeless contest waged against disease by the French is

Oiled concrete drainage ditch near Ancon.

illustrated in the statement made by Capt. Constant Cordier, U. S. A., in the thesis presented by him to the San Marcos University, Lima, Peru, for the degree of Doctor of Philosophy, to the effect that in five years the French lost eleven-sixteenths of the working force, one-third of the number French subjects. Out of the twenty-four Sisters of Charity engaged in nursing in the Ancon Hospital, twenty died of yellow fever. Of seventeen engineers who came on one steamer, sixteen died. During the period of time in which the Panama Railroad was undergoing

construction, and in the eleven years in which the French were engaged in their efforts to construct the Canal, the losses by death from malarial and yellow fever were as great as any suffered by the white race in the history of the tropics.

In the year 1904, when the United States Government took charge of the Canal Zone and began the Canal construction, Col. Gorgas, fresh from the victories won by him in Cuba, was assigned to duty as the Chief Sanitary Officer in the Zone, and began the colossal work of transforming a territorial area of three hundred and twenty-two square miles, surcharged with disease-producing causes, into a region so free from disease that the mortality among the officials and working people is now not greater than that of the towns and cities of our country.

This standard of health was regarded as essential, in order (1) to attract and to protect skilled white workmen who came from their homes in our country, and (2) to maintain a condition of health among all classes of the working force which would contribute to the continuous and successful labor which was necessary in accomplishing the Canal construction. Col. Gorgas was not only charged with the duty of converting the intricate recesses of the jungle into healthful homes for the employees, but also he was confronted with the difficult task of renovating two cities, aggregating in population fifty thousand people, one of which had been for quite two and a half centuries the birthplace and the home of pestilence and disease. Such were the conditions which existed within the Canal Zone which demanded treatment. At either end of the Zone were gates which, unless securely closed against the introduction of infective diseases, would prove to be fertile sources of conditions which would render futile the efforts made to establish correct sanitary methods within the Zone. These were the harbors of Colon, on the Atlantic Ocean, and Panama, on the Pacific Ocean.

Into these harbors came the trade of the World, in vessels from the Eastern and Western Hemispheres. On the Atlantic side the islands of the Antilles and the many ports of the eastern coast of Central and South America had free intercourse with the Zone through the Colon harbor. In many of the ports yellow fever existed in endemic form. History records that for over one

hundred and fifty years yellow fever had existed in Havana, Cuba, as an endemic disease. On the west coast of South America similar conditions existed, many ports not only giving residence to the infective fevers but also to the plague.

In Guayaquil, Ecuador, it is stated that the inhabitants are inclined to rejoice in the presence of yellow fever, as this condition of health keeps out the foreigners who would invade the country and rob them of their business opportunities.

In many of the Pacific seaports the plague has a footing, and during my visit to some of them deaths occurred from it; the same may be said of the Atlantic ports. It is thus to be seen that not only was the Zone area to be purified and purged of disease causes, but it was to be protected from the invasion of disease through the gates of commerce at each end. These conditions, within and without, confronted Col. Gorgas in the organization of his sanitary system, and enhanced greatly the difficulties to be overcome in perfecting it. Two chief propositions present themselves in the study of the sanitary system which was planned and adopted. The first one may be regarded as of major importance—that of the prevention of disease by the removal of causes—and the second, the guardianship of the well and the care of the sick from all causes and of those sustaining injuries in the work of Canal construction.

The general state of health in the community of officials and work people is maintained by rigid inspection of all food issued for consumption, and by weekly examinations and analyses of the water supply from all sources, municipal water supplies, streams, and springs, and condensed water. The houses in which officials and work people live claim special attention, and equally well those of the inhabitants of Colon and Panama City. While the political government of these cities, which are within the limits of the Canal Zone, rests with the governmental authorities of the Republic, the sanitary and police control are supervised by the officers of the Canal Commission under the authority of the United States Government. This is absolutely necessary for the maintenance of public order and of correct sanitary conditions within the Zone. The plans for the construction of new houses must be submitted for approval to the health officers of these

cities, and the buildings within the Zone for the employees are constructed under the same exacting conditions. Owing to the presence of the Plague on both coasts of Central and South America, it is especially necessary that new houses should be constructed so as to make them rat-proof and prevent the harboring of rats. These conditions are accomplished by either raising them three feet from the ground on supports of concrete or other material, covered with tin, so that the rats cannot secure a footing on them, or if placed on the ground they must rest on a floor of concrete. All buildings are submitted to inspection at regular intervals; those not in a sanitary condition in the cities must be placed in that condition, if possible, by the owner, or they are condemned and destroyed. Disinfection and fumigation are practised in all buildings in which cases of infectious diseases have occurred. Permits to repair buildings and to occupy them temporarily or permanently must be obtained from the health officials.

In the cities of Panama and Colon systems of sewerage have been installed, and all buildings must make connections with the sewers. This condition exists in all of the communities in which residential or hospital buildings are located. Outside of the sewered areas in the native villages pit closets are used, and are disinfected weekly with a solution of larvacide, a very effective and cheap preparation, consisting of crude carbolic acid, resin, and caustic soda.

Uncompromising warfare is carried on against the mosquito, anopheles and stegomyia. In the cities and in the regions of the Zone occupied by officers or laborers all breeding places are either destroyed or kept in a sanitary condition, free from larvæ, by oiling or the use of larvacide. Stagnant pools and collections of water are filled up or in large areas drained by ditches which are maintained in sanitary condition. Special attention is given to defective roof gutters, which become prolific breeding places in the water which remains in them owing to the want of proper inclination to carry off all water which comes into them in a rainfall. When very defective by reason of sagging, they are removed, and the owners of buildings are required to replace those thus disposed of by new gutters. In some instances simple punching of the sagging portion keeps the gutter empty.

At first, considerable opposition was met with, and the Governor of the District was requested to amend the decree giving authority to the health officials, so that this important work could not be

THE MALARIAL MOSQUITO (FEMALE) IN STINGING POSITION.

The mosquito acts as an intermediary host, carrying the infection in the fluids of its body, and introducing it into the blood of the human subject through wounds made by its bite. (From the model at the American Museum of Natural History, New York.)

interfered with. All receptacles containing water for use are required to be screened. The constant inspection of known breeding places is maintained, and the mosquito brigade is on

continuous and vigilant duty. Persistent search is made for suspected places, and the surveillance is never relaxed. Although no case of yellow fever has occurred on the Canal Zone since the year 1905, the search for the stegomyia and its destruction continues.

The fact that both the adult and larvæ of stegomyia species are transported by railroad trains exposes the Zone to dangers which require that the most exacting precautions should be taken; their escape from patients before entering quarantine is quite within the range of possibility and greatly increases the

Typical malarial mosquito (anopheles) breeding pool near dump.

work of prevention. Fortunately their recognition is within scientific knowledge, and their detection is thus facilitated. All patients are transported to the hospitals on screened stretchers or in screened ambulances.

Notwithstanding the rigid system of prevention, through sanitary measures which have been established on the Zone, the community is still further protected from the invasion of the mosquito, the breeding places of which may happen to escape destruction, by a most perfect plan of house screening. Resi-

dences particularly are screened, the rustless wire (copper) being employed for this purpose. Not only are the doors and windows protected, but the porches, including first and second story, are securely enclosed. On first view the appearance is novel, and

Water barrel made mosquito proof.

quite suggestive of huge bird cages. The assured safety thus given dissipates any feeling that the inmates are unwilling occupants of the apparent houses of detention.

The known part taken by the fly, the common house fly, in transporting germs of diseases makes it a source of grave danger, and provokes measures of protection against its existence. These

measures consist in supplying all buildings of the Commission with range closets, water and sewer connections. The pit closets in the native villages are, so far as possible, made fly-proof, and are disinfected weekly by a solution of larvacide to prevent fly-breeding. By this means of prevention the fly becomes a "rara avis" within the Zone limits, and is very much less in number than in the villages and towns of our country. During my stay I saw but one specimen, and the comfort and freedom from danger enjoyed in the homes by their absence is very great, and quite in contrast to the conditions caused by them in our homes, be it in the country or in the city.

The rat as the habitat in its hairy integument of the plague flea demands extermination. The annual report of the Department of Sanitation, of the Isthmian Canal Commission for 1909, gives the number of rats caught and killed in Panama City during the year as 17,004; in the city of Colon the number killed was 7284. In Panama City 672 dogs were poisoned, and in Colon 66. The report of the Board of Health Laboratory, included in the report of the Department of Sanitation, contains record of 24 examinations of rabies and suspects, and 11 cases of preventive treatment for hydrophobia were completed.

An interesting item relates to the existence of crab-holes along the shores. In Colon 7600 were oiled and 224,220 were worked. In Cristobel 43,200 were worked, and in Mount Hope 73,229. Grass and weeds afford a harbor for mosquitoes. In Panama City 1,961,395 square feet of weeds and grass were cut and removed. In Bocas del Toro 340 square yards were cut and burned. In Colon 460 acres of vegetation were removed. In Colon 1,319,514 water receptacles were treated, and in Bocas del Toro 554 were overturned—158 breeding places of the mosquito were found in barrels, tubs, etc., and destroyed.

The antimalarial crusade is carried into the houses and into the public eating places of the employees of the Canal Commission. On the tables are placed bottles of the tonic quinine solution which is taken with the meals. Blood examinations are made to determine the presence of the malarial parasite. The complete report of Col. Gorgas for the year 1909 states the issues of quinine for the year to have been 3,148.053 pounds avoirdupois, an average

per month of 262.337 pounds, representing an issue of .06674 pound during the year for each of the 47,167 employees reported as being present and engaged in the Canal construction.

I have selected these few items from Col. Gorgas' report to illustrate, in brief, the character and magnitude of the work carried on to prevent sickness among the employees of the Isthmian Canal Commission, and to maintain a state of health conducive to the most successful results in conducting the constructive work on the Canal. As a test of the success of the sanitary work, it is interesting to consider, among other diseases, the hospital admissions and deaths from malaria in the years 1905 to 1909.

Hospital admissions per thousand of employees: 1905, 514; 1906, 821; 1908, 282; 1909, 215. In 1906, owing to exceptional rains, mosquitoes were bred in many places and in large numbers, and it seemed not quite possible to control their existence by the measures which, under ordinary conditions, proved to be so successful. In the same period of time the deaths from malaria were: 1905, 86; 1906, 233; 1908, 73; 1909, 52. The vital statistics for 1909, as given by Col. Gorgas in his report, show a marked improvement. In 1905 and 1906, with the number of employees 16,512 and 26,547 respectively, the death rate was 25.86 and 41.73. In 1908 and 1909, with the number of employees 43,891 and 47,167 respectively, the death rate was 13.01 and 10.64. In the year 1909 the annual death rate per thousand of 11,662 white employees was 6.43 from disease and 3.43 from violence; total, 9.86. Of Americans, average number 8386, including employees and their families, the death rate per thousand was from disease, 4.05; from violence, 2.27; total, 6.32. A further statement of the death rate of the total population, including the cities of Colon and Panama, and the country between them, shows it to have been in 1905, 49.94, and in 1909, 18.19.

Assuredly nothing can be added to these clear and authentic statements to demonstrate the value of the system of sanitary work inaugurated by Col. Gorgas and so faithfully and successfully conducted by him and his corps of able assistants.

From the consideration of the measures taken to prevent disease it will be interesting to observe how the sick are cared for. For the entire sanitary work on the Zone and in the cities of

Panama and Colon there is a personnel of 1244, the average number of employees at work during the year, distributed in the chief sanitary office, care of property, quarantine service, health officers, in hospitals, sanitarium, asylum for lepers, and dispensaries. There are four hospitals, including a leper asylum, and one sanitarium and nineteen dispensaries. There is a hospital for the insane, which is conducted for the Republic of Panama, which pays to the Commission for each patient, seventy-five cents per day. The Canal Zone Government pays thirty cents a day in the hospitals for patients, and outside patients, as members of the families of employees and others, pay the same. Altogether the paying patients from all sources in the Zone contribute in the year $98,081.72.

Ancon is the Zone town at the Panama end of the Canal and opposite to Panama City. Here is the office of the Chief Sanitary Officer and the Ancon Hospital, which is the largest. This was the site of the French Hospitals. Of the seventy-five buildings for hospital purposes, about fifty were built by the French, which were found by the Americans covered by the jungle. Twenty-five of the buildings are occupied by the Staff. In the Ancon Hospital there are 900 beds for medical purposes, in 27 wards; 320 beds for surgical patients, in 10 wards; 5 wards for contagious and infectious diseases; 2 wards and six rooms for tuberculosis.

A maternity department is conducted for the families of white American employees, who pay in private rooms $2.50 a day and $1.00 in the general wards. Thirty contract physicians are employed by the Isthmian Commission, who report to Colonel Gorgas, Chief Medical Officer. One hundred and two trained nurses, 93 female, 9 male, trained in the United States, are on duty, with 138 attendants acting as orderlies. The Colon, Culebra, and Santo Tomas Hospitals, with the Leper Asylum at Palo Seco and the Tobago Sanitarium, have much less capacity, and require the services of a much smaller corps of officers and attendants. Attached to the daily trains on the Panama Railroad from Colon to Panama are hospital cars, arranged with berths which can be raised and lowered conveniently, forming comfortable stretchers and beds for the sick and injured who may be taken aboard at the different stations, and in this manner transported with a

minimum degree of discomfort to the Ancon Hospital. In charge of these cars is a medical officer, with attendants, who gives attention to patients en route, and such medical services as may be needed. Four chaplains are assigned to duty in the hospitals, and two chapels, one Protestant and one Roman Catholic, supply places of worship. Seven buildings, at different points in the Zone, provided by the Isthmian Commission, are devoted to the work of the Young Men's Christian Association, containing reading, library, and amusement rooms.

The milk supply comes from the dairy, in which there are 93 cows, which were brought from the United States and were carefully tested for tuberculosis before being sent and after arrival on the Zone. Great care is given to the feeding, stabling, and milking of the cows, and prompt measures taken in the treatment of any diseases which may occur. The milk is pasteurized. The poultry farm contains some six hundred chickens which are carefully watched for diseases. An autopsy is made of all dying from disease and the cause of death determined and recorded.

One of the most important sections of the Isthmian Canal Commission is the Laboratory of the Board of Health, forming a part of the department of sanitation, in charge of Samuel T. Darling, M.D., Chief of the Laboratory. Through the courtesy of Dr. Darling I was permitted to observe the methods of work carried on in the laboratory, which made my visit full of interest. The equipment of the laboratory is complete, the Government, through the Canal Commission, providing all that is necessary to conduct the important work of this department. The routine work in the laboratory includes examinations, pathological and bacteriological, for the hospitals, autopsies, surgical pathology studies, Wassermann reactions, blood cultures, vaccines, chemical analyses for the Commission and chemical examinations for the Ancon and other hospitals, of milk and foods (toxicological), special examinations of urine, etc., chemical, bacteriological, and microscopic examination of all Zone water supplies, including five reservoirs. The research work involves various subjects, reports upon which have been published by Dr. Darling. Possibly the most important is that entitled "Studies in Relation to Malaria," published by the Government Printing Office, Washington, 1910.

Most elaborate experiments were conducted in determining some of the factors concerned in the prevention and transmission of malarial fever in the Canal Zone. Among the most interesting results obtained was the determination of the influence exerted by quinine upon the malarial parasite.

The recognition of the mosquitoes common to the Zone, their breeding habits, and the determination made of the species of anopheles hospitable to malaria and those transmitting it claimed critical attention and study. Eleven species of anopheles were collected in the Canal Zone in the five years given to the study. It is interesting to note that observation determined the fact that the characteristic musical note of the mosquito is caused by the vibration of the proboscis and not by the wings, as commonly believed. The proboscis is therefore not only a weapon of offence, but an organ of harmony—an inharmonious combination.

In concluding this necessarily brief and incomplete recital of what sanitary science in this day has accomplished in the conservation of the health of the working community in the Canal Zone, many questions of far-reaching importance suggest themselves for consideration and for study. To one, as is the writer, familiar by actual contact in field and hospital with the appalling conditions which, through the absence of scientific knowledge, confronted the Medical Officer of the Army in the days of the Civil War, great must be his satisfaction in noting the changes which the last half century has wrought in the development and progress of scientific medicine.

In truth and in justice it can be said that in no department of medical effort has progress been more pronounced than in the medical corps of our public service, army, navy, and marine hospital service. The writer feels in this respect that he may be permitted to speak with a shadow of authority as it came to him in his earlier teaching days to place in the medical department of the public service about ninety of his private students. He knew of the conditions existing in those days and of the requirements exacted by the Boards of Examination guarding the gates of admission into the service, and with inspiring appreciation and gratifying pride he has watched the gradual but sure advancement in scientific knowledge and in adaptive methods which have taken place.

The war colleges of our army, the hospital ships of our navy, the research laboratories of our marine hospital service, all speak in resounding tones of progress in scientific medicine, and place our public medical service in the very forefront of achievement among the nations of the world. No longer does the medical department of the different branches of the military and public service occupy the subordinate position assigned to them in the days of the Napoleonic campaigns, or even in those of more recent times.

In the earlier days the commanding general of the army concerned himself much, through his under-officers, about the state of efficiency of his commissary and quartermaster's departments, in order that he might without interruption continue his line of march to meet the enemy and engage him in battle. The medical department was, in a certain sense, an after-thought; the sick and wounded could be left behind in field hospital or in barracks, but the *impedimenta*, the quartermaster and commissary stores, must be in as efficient state as possible. He did not know and his medical officers could not tell him at that time how important, absolutely necessary, it was that the medical officer should march side by side, as it were, with the soldier.

Under his care the soldier endures the fatigue of the march or comes to the battle line as an efficient agent in the conflict; between him and disease and pestilence the medical officer stands, without fear and with undaunted courage, erecting barriers of defence and battling, it may be with greater skill than the officer of the line, against the onslaught of the oft-times concealed enemy. In his hands the soldier becomes a unit of protection against all of the influences of his environment and the methods of his life—he is not only taught to protect himself, but to protect all about him. In a sense every act of his life, as every function of his physical being, becomes the intelligent care of the medical officer. Such, in truth, are the conditions in existence today under the progressive methods which the advanced state of medical science confers.

It may be urged that it requires military discipline to achieve such results as we observe in the Canal Zone. Recognizing, as we all must, the influence exerted by a state of military control

in conquering unsanitary conditions, and in obtaining unresisting compliance with those which are conducive, in all respects, to the conservation of health which may be permanently maintained, we find some examples of places presenting conditions similar to those which had existed in the Canal Zone, and which have been completely removed by civic efforts.

In a visit made in the last winter to South America, I landed in Santos, Brazil, a city of 41,000 population, and one of the best ports on the Atlantic Ocean. A few years ago this port was devastated by raging epidemics of yellow fever. To such extent did the disease prevail that vessels coming into the port lost in several instances, and very quickly, their entire crews from the disease, officers and men, before they could be unloaded. I was told of one instance in which a vessel lay anchored in the harbor for a period of eighteen months, unloaded, with cargo perishing in the hold.

Inspired by the fact that this city was the greatest shipping port of coffee in the world, the government and municipal authorities inaugurated a system of modern hygienic improvements which destroyed the breeding places of the stegomyia mosquito, and banished yellow fever, converting its beautiful harbor from a home of pestilence into an attractive seaside home, with the ships of many nations unloading and loading in guaranteed security alongside of its commodious and well-arranged quays.

Such results had been obtained by civic effort, and they may be accomplished in other places where knowledge of sanitary science, combined with intelligent coöperation—freed from the demoralizing and destroying grasp of the political boss, surcharged with graft—is employed in correcting unsanitary conditions, conducing, in this manner, to the prevention and to the staying of the ravages of disease.

The world should not, as we hope and believe it will not, look again upon a picture such as the Chickamauga Camp in the Spanish-American War, which portrayed in such lurid colors the humiliation of American medicine and as well the inefficiency of military control. While it is true we were on the eve of discoveries of great import, born of the experience which we gained in the occurrence and in the progress of the war, it may

be said, without fear of successful contradiction, that the conditions which provoked such holocausts were in large measure preventable. It is true that we did not know of vaccination as a prophylactic measure against typhoid fever—a recent gift of laboratory research and of experimental medicine, which will take its place with vaccination against smallpox, as a monumental contribution to the promotion of the well-being and welfare of the human race—we did know, however, of the great necessity of microscopic, chemical, and bacteriological examinations of food and drink supplies. The bacillus of typhoid fever had been isolated in the year 1880, and we knew the importance of its destruction in the excreta. We knew of the necessity of maintaining all sinks and pits in rigid sanitary conditions, destroying by the free application of the most powerful disinfectants all microörganisms. Our knowledge, at the time, of the part taken by the common house fly in conveying disease germs was sufficient to provoke measures of protection against it, and the employment of agents to prevent fly breeding in all places favorable to such conditions. We had sat for two decades or more under the instruction of the great teacher who had taught us the far-reaching principles of *antisepsis*, and had demonstrated its practical application in all conditions involving the sick and wounded—the subjects of the wounds of accident and of the wounds of intention. We knew the value of incineration in the disposal of all refuse matter. The gospel of Cleanliness, evolving *asepsis*, as the physician and the surgeon understand it, or should understand it, had been preached abroad in the land, enjoining all to be clean, through its unremitting application in practice.

All of these things and many more we did know, and yet the dread disease typhoid fever stalked through the camp, apparently unrestrained, laying low one-sixth of the entire command—20,000 cases out of an army corps of 120,000 troops—with a case mortality of 7 per cent. The annals of civilized warfare do not present a page quite so black, recording conditions which the knowledge of the day should not have permitted to exist.

The progress of scientific medicine is onward, and today in the camps of our armies, on the battleships of our navy, and at the quarantine stations of our marine hospital service it shines with

added lustre, the medical officer taking his place, as of right it belongs to him, in the front rank with those whose efforts contribute to civil and military efficiency. Moved with pride by the achievements of his noble profession and inspired by loyal devotion to the corps of which he is a member, he bears aloft the banner of progress and scientific research, unfurled by that distinguished disciple of medicine and honored medical officer of the United States Army, William Beaumont, who nearly a century ago gave to the world and to scientific medicine, obtained through accurate research work in the living subject, the first knowledge it had of the functions of the stomach and of the constituent elements of the gastric juice and their action on foods. His name will live as the pioneer in scientific research in the history of American medicine.

Truly, may we not congratulate our professional brethren who have so unselfishly devoted their talents and their lives to the service of their country upon the great work they have accomplished, which stirs our national pride, and proclaims to the world their monumental achievements, as the President and their Commander-in-Chief has so well proclaimed them, "Marvels of American courage, energy, and scientific thoroughness, skill, research, and original discovery." So long as preventable destroying diseases flee before the conquering hosts of efficient sanitation, so long will the labors of these noble benefactors of the human race be cherished. Upon their brows we place wreaths of victory, laurels won not in the fierce conflict of clashing arms, but in the home and in the daily walk in life, over which the Angel of Peace spreads her golden wings. As we acclaim them victors in peace, no less than in war, we enshrine them in the grateful hearts of their countrymen.

THE CONTROL OF BLEEDING IN OPERATIONS FOR BRAIN TUMORS.

WITH THE DESCRIPTION OF SILVER "CLIPS" FOR THE OCCLUSION OF VESSELS INACCESSIBLE TO THE LIGATURE.

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All surgeons who make for themselves opportunities to observe the manipulative work of their fellows must appreciate the present general tendency toward the abandonment of the applauded methods of comparatively few years ago. The conditions under which Cooper, Pott, and Abernethy worked have long since been changed, and though the by-the-clock methods which were essential to operative success in their day are still emulated in some of our present clinics, the stirring, slap-dash, and spectacular is rapidly giving way to the quiet, patient, and undramatic performance.

The elimination of pain has made hurry unnecessary; due respect for the principles which have grown from Listerism has made it inadvisable; the emphasis laid by Halsted on detailed blood-stilling during major operations has proved a further check; and lastly, an expectation of the reactionless healing which occurs only in tissues handled with the greatest delicacy and coapted with scrupulous care is prohibitive of haste and the old-time thrills for the bystander which accompanied it.

There are special reasons why the utmost precaution in anesthetization, the gentlest methods of handling tissues, and the most accurate closure of wounds, accompanied by as painstaking hemostasis as possible, should be observed during the

more difficult intracranial procedures. Neighborhood oozing obscures the clear view essential to the safety of such delicate manipulations as are required for the removal of, let us say, a lateral recess tumor or the trigeminal ganglion; whereas a more general loss of blood with the consequent lowering of arterial tension is a cordial invitation to its near relative shock, favors the onset of respiratory paralysis in cases associated with medullary pressure, makes anesthesia more dangerous, and lowers resistance to infection through secondary anemia.

These are premises, I am aware, which are not accepted by all surgeons, for many still feel that high-geared methods of operating can outdistance these largely imaginary risks, and there is a widespread apprehension lest observance of these minutiæ engender a reputation of being a slow and fussy surgeon. For, after all, what do these details amount to, with another patient awaiting his turn and an assistant who can close the wound, put on the dressing, and administer stimulants and infusions. But for those who grant the premises and agree that every effort should be made, even at the expense of time, to respect the tissues and to minimize the loss of blood by whatsoever methods one can summon to his aid, there are certain "tricks" which may be found useful, particularly in cerebral surgery.

It is necessary to bear in mind that two fairly distinct vascular systems will be encountered—internal and external. On the arterial or carotid side these systems are quite distinct, but on the venous side the communications between them are so free that, under conditions of intracranial stasis, brought about by a growth producing an increase of tension, the venous return from the internal system is in large part shunted into the extracranial field. For this reason—though the "tricks" to be spoken of apply chiefly to the internal system of vessels with a cerebral and meningeal distribution—it may not be out of place to preface a few remarks concerning ways of combating loss of blood from the external coverings through which the approach to the more important structures must be made.

Throughout this paper the more critical cases will be considered. If precautions are taken to meet the serious problems of hemostasis which the critical cases present, the simpler and less complicated ones can be more often carried through to a successful termination at one sitting. Furthermore, the discussion will be largely restricted to the osteoplastic type of operation on the cranial vault; for if its principles are mastered, operations in situations which forbid the use of a tourniquet or those in which a bone flap is prohibited may be conducted with comparative ease.

The Scalp. That a trifling wound in a normally vascularized scalp may bleed abundantly is familiar enough. But when stasis of the extracranial vessels has been produced by a cerebral tumor, the loss of blood incidental to the long incision needed for an osteoplastic resection may be disproportionately excessive, unless precautionary measures are taken. Many devices have been suggested to control bleeding from the scalp, none of them in the long run being as efficient as a properly applied tourniquet. This, in any event, will control the arterial supply to the operative field, and if there is no cyanosis under the anesthetic and no unusual widening of the emissary venous communications between the internal and external systems, not a single hemostatic adjunct may be required. When, on the other hand, venous stasis has long existed and wide communications have formed between extra- and intracranial veins, the scalp will fill with blood and require the placement of clamps, no matter what device be employed. But even under these circumstances, the convex side of the incision toward the flap remains dry—a desirable result, as it avoids the risk of stripping scalp from bone through the weight of pendent instruments. When it is necessary to place clamps on the concave edge, even though the bleeding points may lie in the tough scalp proper, it is best to catch the galea and allow the mere weight of the clamps to close the bleeding points. This precaution will avoid superficial points of tissue necrosis, which militate against the subsequent reactionless

healing. The flat T-shaped clamps which have been devised for the scalp are, I think, undesirable, for the reason that they are difficult to place and are likely to damage the tissues.

As many of these more desperate cranial operations must require two or more stages before their end, it is essential that the utmost pains be taken in closing the wound to assure an epithelial approximation which will permit early removal of the external sutures. Needless to say, if there are points of staphylococcal stitch infection, or even granulating edges, owing to inaccurate closure, the reopening of the wound after a few days, and possibly the later reopening after a subsequent interval, is accompanied by special risks of infection.

Our local method of closing these wounds is to bring the edges of the galea together by a series of interrupted and buried fine black (iron-dyed) silk sutures. This row of buried sutures oftentimes so closely approximates the overlying tough scalp as to render the placement of cutaneous sutures hardly necessary, were it not for the fact that they are destined to control the arterial bleeding which would otherwise ensue on the final removal of the tourniquet. A satisfactory method of placing these sutures before they are tied, by a row of round, fine intestinal (cambric) needles, has heretofore been described.[1] They should be removed after thirty-six or forty-eight hours; and by the fourth or fifth day the incision is hardly visible, there are no points of reaction due to suture constriction, and epithelium covers the entire field.

The present paper is not an essay on wound closure, though such an essay might well be written, for many, I am aware, regard this step as so unimportant a detail of an operation that its performance is beneath the dignity of the operating surgeon himself. It is, however, a deserving detail of these measures, not only when a subsequent reopening is premeditated, but for the reason that in the case of a fresh first-stage wound, especially when clamps have been necessitated, owing to venous stasis, some further loss of blood will occur during

[1] Keen's System of Surgery, 1908, vol. iii, Fig. 152, p. 272.

the closure. For it is inadvisable to attempt to ligate the bleeding points in the tough scalp, as the external approximating sutures may be relied upon to effectually control them; and to place and tie these sutures accurately and rapidly, requires a full and not a crippled operative team.

Impatience to attain results is characteristic of the species surgeon and often leads to the taking of unjustifiable risks—one of the reasons for the high mortality ascribed to major intracranial procedures, those for tumor in particular. The writer is no exception and constantly finds it necessary to curb himself in the desire to do just a little more. But far more tumor operations have been carried to a successful outcome by the courage to temporarily withdraw after a bad start than by banging at hazards. Annoying though it is, it may improve one's score when in difficulties to play back with the loss of a stroke.

Postponement may thus be justifiable merely in view of a badly taken anesthetic—and no tumor patient in whom pressure is considerable takes the anesthetic any too well, even with the most skilful administration. At a subsequent trial circumstances may be more fortunate, or a preliminary dose of scopolamine with morphine or atropine, or a combination of chloroform and ether, may serve to offset the earlier difficulties. For cyanosis increases intracranial pressure by accelerating cerebrospinal fluid secretion,[1] which adds to the venous obstruction and so to the loss of blood—a bad cycle all around. But rare though

[1] This is particularly true of ether, which, though the safest drug to employ, is unquestionably the most difficult to administer; and needless to say, its use should be in expert hands. There is less bleeding with chloroform, owing to the fact that it lowers arterial tension; but this in a way is comparable in its consequences to an actual loss of blood and so must be regarded as hazardous, as has been emphasized heretofore. And there are other hazards in the use of chloroform which formerly we did not recognize, namely, the hepatic necroses which in greater or less degree are a constant feature of chloroform administration and are particularly extensive after a readministration, when, as Dr. George A. Whipple has found, there is a special tendency even to spontaneous bleeding, owing to the loss or diminution of one of the elements necessary to clot formation.

it may be to have to abandon progress toward the final stage, owing merely to a badly taken anesthetic, postponement is not infrequently advisable because of excessive loss of blood from scalp and bone, and such a postponement would hardly seem an advance at all were it not for the fact that a blunt reopening of the uniting superficial wound after a few days is attended with relatively little bleeding.

The Skull. All grades of vascularity may be encountered, and chief reliance must be placed upon the proper use of proper wax, for the introduction of which Horsley deserves the lasting gratitude of us all. The cases which present the greatest difficulties are those in which a superficial tumor of long standing receives or discharges much of its blood supply through the diploetic spaces of the bone. This is particularly true of the large dural endotheliomata, which are often associated with extreme vascularity of the adjacent skull, even though the immediately overlying bone may be thinned by pressure atrophy. The enlarged diploetic channels, in these cases, sometimes the size of a radial artery, are often traceable on the radiographic plates, which in this way may be useful even though they rarely show actual shadows of the tumor. At times the very surface of the exposed skull may be so roughened and vascular that it must be rubbed with wax to check the extensive oozing from countless points.

But even with the generous use of wax, considerable loss of blood may be unavoidable in the process of outlining the bone flap under these conditions of abnormal vascularity with extreme venous stasis. For though extravasation from the bone edges may be controlled, it is less easy to combat the free bleeding due to the separation of meningeal emissaries, particularly if the incision be carried into an area of new-formed arachnoidal villi with a distribution beyond the usual confines of Pacchionian granulations. In any case it is well to give the longitudinal sinus and its lateral lacunæ a wide berth, and not to outline the mesial edge of the proposed flap nearer than two or three centimeters from the midline. Should an exposure of the

foot area be deemed necessary, the safest method of approach is to turn down a low flap and subsequently cut out a bay from the upper edge, leaving a permanent defect over this dangerous vascular area.

Whether one prefers to outline the bone flap with electromotor or hand-driven instruments—and I regard the latter as much the safer—bleeding is likely to occur from the lacerated osteodural communications at the upper margin. For this reason it is our custom, after making the primary large trephine opening and the secondary opening with a perforator and burr, to immediately pass a dural separator between the two, so as to break up the vascular attachments at this early stage. For when the instrument is withdrawn, the cerebral tension is sufficient to again plaster dura against bone and effectually check the bleeding, so that by the time the lateral margins of the flap have been cut, many of the emissary vessels will have become spontaneously occluded.

Postponement at this stage, owing to loss of blood, may sometimes be desirable, even before the flap, though thoroughly outlined, has been lifted away from the adherent dura. The advisability of this can often be gauged by the anesthetist better than by the operator, and by a blood-pressure tracing better than by a finger on the pulse. The procedure up to this point has been a brief one, there will be a quick recovery from the anesthetic, and a certain amount of pressure relief will be experienced through the slight elevation of the still adherent flap.

It is of course far more often possible to elevate the bone flap, for conditions such as may have rendered postponement advisable at a stage earlier than this are naturally rare. One must realize, however, that it takes nearly as long to get out of as it does to get into the intracranial chamber, and as there is likely to be about as much bleeding during the process of withdrawal as during entry, such blood as may be lost during further advance must be multiplied by two. And one should not wait for a profound upsetting of the pressor mechanism, for it does not go to pieces gradually, but suddenly. This

is well exemplified in transfusions, for a large amount of blood may be given up by the donor with no appreciable change in his condition, until a little pallor, increased respiration, and restlessness indicate the need of uncoupling. Checking the flow at this stage is followed by complete readjustment within a few moments, and one is often thus misled into the thought that more blood might safely have been withdrawn; but this extra straw will often so upset the regulatory mechanism that hours or days are needed for a complete restoration.

THE DURA. We have come to a stage of the osteoplastic operation which calls for special tricks of hemostasis, and the following adjuncts have been found useful: (1) *Small pledgets or "tips" of gauze* of various sizes secured by a black ligature, so that though blood-stained they can be easily located—minute Mikulicz pads as it were. (2) *Sterile absorbent cotton* to be used *dry* and plastered on an oozing surface, or *wet* in hot saline solution, a bowl of which at a temperature of 100° to 105° F. should be on the instrument tray immediately at hand. This dripping cotton is the best material for washing meningeal surfaces, and, when wrung out into flat pads, is the safest and most effectual substance for sponging or for temporary placement in deep cerebral wounds. (3) *Bits of living tissue*—supplied, for example, from the exposed temporal muscle—which serve admirably as a means of checking venous extravasation from points on the dura, and *fragments of partially organized blood clots*, obtainable at a second-stage performance, are similarly useful. Finally (4) *silver wire "clips"* for placement on inaccessible vessels, which, though within reach of a clamp, are either too delicate or in a position too awkward for safe ligation.

On first elevating the flap there may be, particularly in cases with stasis, quite an abundant loss of blood from the raw surface of the dura. This bleeding comes from two sources, arterial and venous; that from the latter being by far the more troublesome; for only in case of a torn meningeal at the lower anterior angle, due to its having deeply channeled the bone where this has been broken in turning back the flap, will arterial

bleeding give trouble. When this occurs it is naturally the first thing to need attention, and if there is venous bleeding from the raw dural surface, it can meanwhile be temporarily controlled by promptly covering the whole surface with a large pad of the hot and dripping cotton, which is immediately dried out against the oozing dural surface by pressure with a gauze sponge. The arterial bleeding should then be checked without attempting to catch or ligate the vessel, which may be torn back "hang-nail" fashion. Some of the prepared gauze pledgets of proper size can be tucked under the bone, separating the dura from it until a point is reached where the vessel no longer channels the bone. Then the pressure of the pledgets against the tense dural surface will control the bleeding until later in the operation, when with an open dura the vessel can be caught by a "clip" if it proves to be inaccessible to a ligature.[1]

Permanent control of the venous bleeding is a more difficult matter. The artery, as its branches approach the upper part of the exposed area, is accompanied by many dural veins which have a more or less intimate connection with the bone, and many raw, bleeding points may be left after their separation. These points, especially if associated with Pacchionian granulations, may give a great deal of trouble during the further procedure, and indeed may continue to ooze after replacement of the flap and closure of the wound; and thus in the course of a few hours a thick extradural clot may form and give pressure symptoms. In our earlier experiences this was an occasional postoperative complication, and even now the possibility of its occurrence is always considered. The fact that dura and bone have been separated makes the formation of such an

[1] Loose gauze pledgets of minute size, possibly a centimeter in circumference, are particularly valuable in ganglion operations. For one of them can be plastered against a bleeding point, say at the foramen ovale, and its anchoring ligature led out of the wound, leaving a sufficient exposure of the remaining field to allow for further progress in separating the dural envelopes. By using the proper tricks to control hemorrhage, in none of our last seventy-five cases has it been necessary to postpone a ganglion operation until a second session, and in none has it been necessary to place a drain.

extradural clot possible, as the result of slow venous oozing, whereas in the ordinary extradural hemorrhage of traumatic origin the extravasation comes necessarily from a ruptured artery. In other words, the tension of a purely venous extravasation under the latter circumstances would not suffice to peel the adherent membrane from the bone.

Even when the venous oozing seems at the close of the operation to have been effectually checked, postoperative vomiting or straining may start the bleeding anew by dislodgement of terminal thrombi, and for this reason in all cases in which the performance has been a bloody one the patient should not be lifted from the operating table until he has recovered in large measure from the anesthetic. The table, therefore, should be made sufficiently comfortable by having a thick mattress covering, for it may be inadvisable to move the patient for two or three hours, and, indeed, it is not exceptional for critical cases to be kept in the adjoining recovery room over night before they are transferred to the ward. With such precautions, in addition to skilful administration of the anesthesia, postoperative retching and vomiting are rare.

Oftentimes the gauze "tips" or pledgets of cotton, which during the progress of the operation have been used to cover, and which have become adherent to bleeding points in the dura, cannot be removed without starting the bleeding afresh, so that one is occasionally tempted to leave the foreign material plastered against the dura in the hope of its becoming safely organized. This, of course, is undesirable (though we have found in animal experimentation that the cotton pledgets, as a rule, are well cared for) and also unnecessary, for an alternative has been discovered in *bits of living tissue* or *well-solidified blood clots*. Small snips of tissue may be cut from an exposed raw surface, such as the temporal muscle—and muscle seems to be particularly valuable as a hemostatic—and when held for a moment on the bleeding point by a smooth instrument they will adhere more promptly and check further extravasation far better than gauze or cotton. Since this device for checking

bleeding was first hit upon some two years ago, we have made frequent use of it, with most satisfactory results.[1]

It is possible that any living tissue will suffice. In a recent case of extirpation of a cerebellopontine tumor a troublesome point of venous bleeding was left at the side of the pons. It was controlled by a small piece of dura which, as the most available tissue, was cut off and plastered against the side of the brain-stem, adhering and effectually checking the bleeding after a few moments of gentle pressure. Organizing clots may also be utilized. They are particularly available in second-stage procedures; and at present, instead of scraping away the clots from primary trephine openings and discarding them, they are carefully preserved in saline gauze, and sections of them utilized in the same way as the bits of muscle tissue. Doubtless it will be found that tissue fragments can be prepared beforehand and kept sterile for this purpose.[2]

It is at this period—with a reflected bone flap and all bleeding from the dura checked—that postponement is most often advisable, not only on account of the loss of blood up to this stage, but more particularly should the membrane be so tense that cerebral protrusion of a dangerous degree is likely to occur through an immediate dural opening. Under these circumstances, even in the bone-flap operation, the principles of

[1] Since this paper was put together I have learned from Dr. Lund's interesting report of the visit last summer of the Society of Clinical Surgery to Great Britain that Sir Victor Horsley demonstrated "the hemostatic action of a fragment of muscle" on the exposed brain during the progress of a laboratory experiment. It is not unlikely, therefore, and is indeed probable, that one or all of the "tricks" which I have here set down have been in use by others who have not regarded them of sufficient importance to record.

[2] If Bernheim's conclusions (Jour. Am. Med. Assoc., 1910), that the walls of the bloodvessels possess more active clotting elements than do other tissues, prove to be correct the walls of preserved vessels may be applicable for this purpose; or the fibrin from whipped blood might be so prepared that it could be immediately plastered on bleeding surfaces, just as cotton is now used, and thus obviate the necessity for any subsequent replacement. Or, as Carrell has suggested (Jour. Exper. Med., 1910, xii, 460) for the preservation of bloodvessels, we may be able to preserve tissues *in vitro* for these purposes in a condition of "latent life."

decompression come into play; for it cannot be emphasized too strongly that a rapidly forming hernia, comprising functionally important areas of a tense cortex which protrude through an immediately superimposed dural defect, often leaves irrecoverable paralyses. Hence, unless a tumor is obviously subjacent and there is every prospect of its removal at the first sitting, recourse should be had to a temporary palliative measure with a dural defect over a silent and preferably over the subtemporal area.[1]

In the making of a palliative subtemporal defect, whether a primary operation or one to be combined with a temporary osteoplastic resection, it is important that the fibers of the overlying muscle be preserved as intact as possible. This necessitates, particularly in the case of a primary decompression, the careful rongeuring away of the thin bone of the temporal region far under the edge of the split muscle, with an exposure of an area of dura carrying the main branches of the middle meningeal artery. Hence, when the dura is incised radially from a primary central opening to the margins of the bone defect, some of these branches, particularly the posterior radicle of the artery, are likely to be divided, and unless precautions are observed, bleeding may be troublesome. If the spoon-shaped spatula[2] is used to hold the tense brain away from the dura while the radial cuts are being made, the arterial branches can usually be seen before they are divided, and a delicate clamp of the Halsted pattern can be applied on each side of the incised membrane even in the deeply overlain parts of the wound inaccessible for ligation. But what to do with these deep bleeding points after they were thus caught often gave us great concern in our earlier operations; and on one or two occasions it was necessary to divide the muscle transversely in order

[1] A useful method of combining at this stage a decompression with the exploration has been elsewhere described (Surg., Gynec., and Obst., 1909, iv, 1-5). It has been put into practice in some thirty or forty cases with uniform satisfaction in the results.

[2] Surg., Gynec., and Obst., 1909, vol. iv, p. 3, Fig. 2.

to obtain sufficient exposure for ligation. These difficulties have been overcome by means of silver "clips"—a device which possibly deserves the special description given to it later in this paper.

The Brain. The central nervous system can be seriously damaged in the attempt to employ the usual methods of hemostasis with gauze, clamp, and ligature, commonly used for other tissues. From its first exposure, every effort should be made to avoid any injury to the pia-arachnoid until the actual moment of entry to the subcortex for the purpose of exploration or enucleation of an obvious growth, and such entry and proposed enucleation must be carefully planned out in accordance with the disposition of the cortical vessels. A safe enucleation may be completely frustrated by gauze sponging or otherwise roughly handling a brain under tension, by the protrusion and rupture of the tense cortex through the primary dural opening, by the accidental injury of a cortical vein carelessly wounded during the enlargement of the dural incision. The struggle to control the consequences of these seemingly trifling matters, which leave in the end a large patch of broken and infiltrated cortex through which ligatures have cut and against which gauze sponges have been held, is only too familiar, and operations for tumors are usually terminated by such an occurrence.

Familiarity with the tricks of lessening tension is all-important in the prevention of these accidents, and the different methods of dealing with a "dry" or "wet" brain by primary decompression, by pricking arachnoid spaces, by ventricular or lumbar punctures, by changes of posture and what not, is a subject too large to be dealt with in the present paper, though indirectly bearing a close relation to loss of blood incidental to manipulations of the nervous tissues themselves. The whole matter hinges more on the disturbances of cerebrospinal circulation than upon the size and position of the tumor. For with a smoothly taken anesthetic there may be little or no difficulty in manipulating a brain holding the largest of growths, whereas cyanosis with increase of stasis may make the exposure of a

brain, under previously normal conditions of tension, hazardous in the extreme. A small growth of the brain stem, on the other hand, may lead to a great stasis of fluid, the embarrassments from which can be promptly set aside by a ventricular puncture. In any event, a satisfactory subdural exploration can only be made after a considerable diminution in tension has been brought about in one way or another.

The question of tension, furthermore, is quite apart from the actual primary vascularity of the growth, for some of the most vascular lesions, which consequently are difficult to handle, fortunately may be uncomplicated by tension, just as tense brains may hold relatively non-vascular growths which are readily enucleable. However this may be, great care should be exercised in attacking a growth when once it has been brought into view and has been given the wide exposure essential to a safe attempt at extirpation.

Notwithstanding the statement of physiologists to the contrary, one rarely if ever sees "shock" in cerebral operations as a thing apart from hemorrhage or injury to some vital centre. This is abundantly supported by certain of our experiences with extensive cerebral manipulations at second-stage operations in unanesthetized patients. Hence, with careful choice of the stage at which an extirpation may be attempted—meaning largely an unbled subject—an abundance of time and patience should be expended in the careful and slow manipulations necessary for the dislodgement of the tumor. The tearing out of a growth by the insertion of the fingers means a fragmental removal, extravasation and edema from unnecessary damage, and blind points of hemorrhage most difficult to identify. On the other hand it is astonishing how dry the subcortex may actually be if care has been taken in respect to the superficial vessels. One can usually find a safe point of entry through the cortex, and much of the remainder of the operation consists in the slow separation of brain from tumor, working now here, now there, leaving small, flattened pads of hot, wrung-out cotton to control oozing for the time being from a given area,

until it can be again attacked. I know of no better training in such procedures than can be gained by the experience of making clean-cut extirpations on the lower animals—let us say of the motor territory of the canine brain.

A few fine silk (bead) ligatures may be passed on delicate curved needles to secure some of the vessels crossing the line of proposed cortical (circumferential) incision, if one is necessary, but care should be taken not to include the large *venæ anastomoticæ* or important branches of the middle cerebral artery, lest outlying areas of softening result and leave unexpected and unexplainable palsies to be answered for. Indeed, it is often surprising how widely one can push aside many of these vessels in the pia-arachnoid which at first would seem unquestionably to need ligation.

The actual tilting out of a tumor is largely a one-man performance, and the operator's left hand is necessarily occupied in holding and guarding the tissue in process of separation. The manipulations meanwhile are carried on by slow, blunt dissection with the right hand, while an assistant keeps the field clean by the careful use of wet cotton pledgets. During the progress of the measure, particularly in the case of a deeply seated tumor, vessels may be encountered passing from brain to tumor and lying in tissues in which it is obviously futile to place an ordinary hemostatic forceps. Under these circumstances the silver "clips" to be described may be found to be useful, just as they are in the presence of dural bleeding from points awkward of access; for the jaws of the instrument holding the clip will pick up the visible vessel or bleeding point just as would the ordinary clamp, the "clip" being left to take the place of an actual pendent instrument.

Despite the rapidity with which the surrounding brain tends to fill up the gaping hole left by the final dislodgement of the growth, the raw surface of the cavity may continue to ooze. This condition can best be controlled by filling the hole with a wad of dry absorbent cotton which is replaced as it becomes saturated. Ultimately the contracting cavity will be left

sufficiently dry to justify closure without drainage, for a drain leading from the nervous tissues to the external world should never be used if it can possibly be avoided. The cavity, even if large, should be filled with normal salt solution and the dura closed as accurately as possible over it. Even if it has been necessary to leave a defect in the dura overlying the cavity, the same principles are to be adhered to.

It was formerly our custom, in order to draw off the excess of bloody fluid as the brain tended to swell and fill the cavity, to leave one or two folded protective wicks, which were led from the cranial chamber through the primary trephine opening to a puncture in the scalp, outlying the original line of incision. For in this way an oblique passage is insured, and one which is easily occluded by pressure after the withdrawal of the wicks. But particularly in second-stage performances we have found this to be less and less necessary as we have learned how to leave a dryer wound. In the case, for example, of the tumor pictured in Fig. 3, the huge cavity left by the removal of the growth was merely filled with salt solution, the flap replaced, and the wound closed with no drainage whatsoever.

SILVER-WIRE CLIPS AS LIGATURES.

The thought has doubtless occurred to many that much time and trouble would be saved in major operations could there be devised some form of hemostatic clamp, the mere placement of which would leave a fine, knotted ligature on the bleeding point so as to obviate the alternatives which we now possess, either of leaving a pendent instrument or taking the time necessary for ligation. Someone will probably have the ingenuity to construct an instrument of this kind, which will be useful not only for such extensive performances as complete breast amputations, where many delicate vessels must be secured along the axillary vein and where the temptation is great to leave dangling a heavy mass of clamps, but also in operations during which vessels are necessarily divided at

depths easily reached by a clamp but in positions awkward for ligation. It was doubtless this thought, coupled with a knowledge of the ingenious instrument used by some surgeons for closing skin wounds by the superficial placement of removable, toothed metal bands, that led to the device which we have come to employ.

Some three years ago a small U-shaped bit of wire held in the jaws of an ordinary clamp was first successfully used to check bleeding from a troublesome meningeal vessel divided in a subtemporal operation. As further trials were made on subsequent occasions, the difficulties of holding the small bit of wire in position were overcome by an indentation (Fig. 1, 4) in the blades of the clamp in which the wire could securely lie. The wire U's have finally come to be made in large numbers and of equal size by cutting them from a flat metal pencil, around which the wire has been previously wrapped (Fig. 1, 1). In order to furnish clips which will not slip easily from the tissues on which they are placed, the metal pencil is longitudinally grooved, so that by lightly tapping the wire, after winding, the inner surface of the loops becomes transversely ridged. A deep median groove allows the pointed wire-cutters to snip the several loops (Fig. 1, 1) of the same size. They are then loaded on a magazine and picked up individually, as needed, by the holder (Fig. 1, 2). The first "catch" of the holder locks its sprung handles at a point which closes the jaws sufficiently to enable them to take up the loop from the magazine without deforming the easily compressed wire, and the instrument unlocks itself when the U has been flattened against the bleeding point (Fig. 1, 4). These matters are made sufficiently clear by Mr. Becker's excellent drawing without further description.

The instrument in its present form has been put to use at some stage or another in almost all of our operations on the brain during the past year or two. Like any tool, however, a certain amount of experience is necessary before it can be used with facility. In the hands of some ingenious mechanic it would doubtless be capable of much greater perfection; it

would be well to have a self-loading tool if one could be constructed without its being too cumbersome.

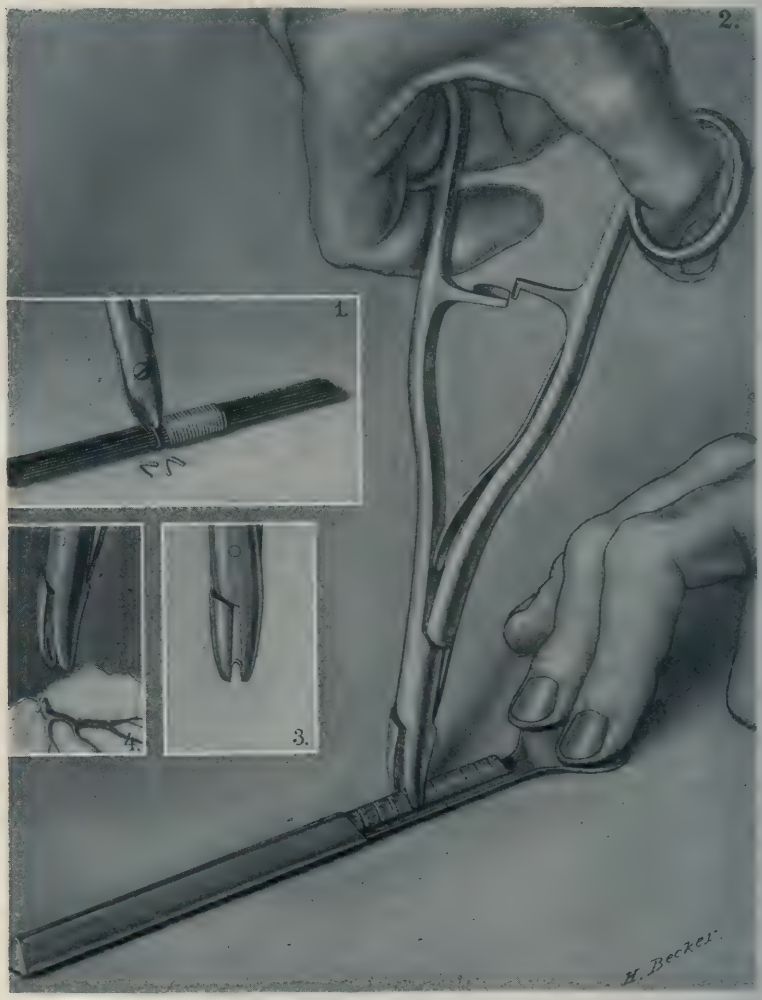

FIG. 1.—Drawing to show (1) silver-wire loops being cut after wrapping on grooved steel pencil; (2) one of the clips being picked up from the loaded magazine; (3) clip in position in jaws of holder; (4) clip placed on meningeal vessel at the edge of a dural incision, the empty instrument showing the mould for the clip. (Reduced one-third.)

The "clips" have been found useful for the occlusion of inaccessible vessels divided in the dural incisions of decompressive operations (Fig. 2); for the occlusion of the meningeal at the foramen spinosum if its division is advisable during

FIG. 2.—*X*-ray of a patient's head after subtemporal decompression, during which four clips were placed on bleeding points in the dural margin. Showing unobstructed view of normal sella turcica, two of the clips being in line with its posterior border.

the operation for trigeminal root avulsion; and, as has been stated, during the enucleation of cerebral tumors, for the occlusion of the vessels passing from cortex to tumor—vessels the position and delicacy of which often make ligation well nigh impossible (Fig. 3).

Though from the present character of my operative work I have had little opportunity to test the value of these silver "clips" in operations other than those on the brain, I can recall occasions in intra-abdominal work when the instrument would have been most useful—occasions when a bleeding vessel, such as the artery of the cystic duct, in the depth of the wound could be caught by a clamp, but in a position difficult for liga-

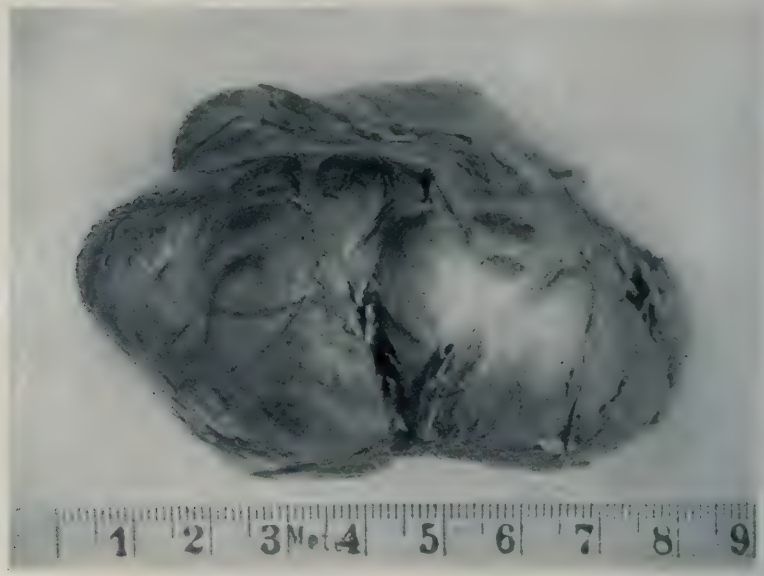

FIG. 3.—Dural endothelioma (actual size) with adherent clips. Tumor successfully extirpated at second stage, weighing 200 grams. Bone-flap operation; closure without drainage; uncomplicated recovery.

tion, particularly if the operator's left hand was occupied in holding the viscera aside to secure the necessary exposure. The "clips," however, have been utilized in a recent enucleation of a large intrathoracic thyroid tumor (*goitre plongeant*) in a case of acromegaly. The tumor, the descent of which had doubtless been encouraged by the skeletal enlargement of the upper thorax, had exerted pressure against the superior vena cava, and venous stasis of the entire upper body was so extreme

as to give an appearance of a malignant mediastinal growth. During the process of dislocating and delivering the growth from its subclavicular position, many of the inferior thyroid

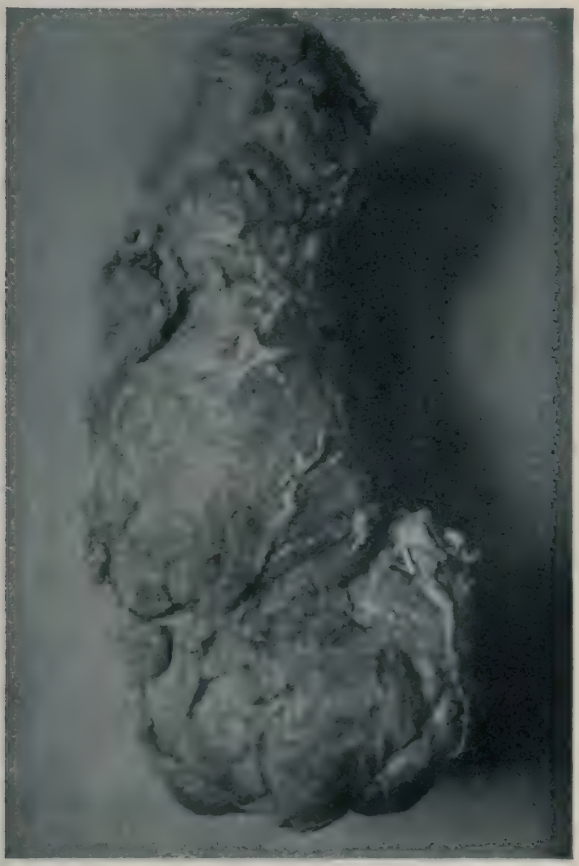

FIG. 4.—Clips adhering to the inferior thyroid stump of an enucleated intrathoracic goitre (slightly reduced).

vessels below the clavicular level were clipped before their division in positions which would have made ligatures very difficult to apply and the placement of a number of clamps out of the question (Fig. 4). "Clips" similarly have been success-

fully used by Emil Goetsch in such delicate procedures as the experimental occlusion of the canine hypophyseal stalk, and by S. J. Crowe for securing the bleeding points after a tonsillectomy. It is not improbable that similar instruments fashioned to carry loops of stouter wire and of larger caliber might prove useful in occluding vessels larger than those for which we have heretofore used the device.

SUMMARY. One of the chief objects of concern in intracranial surgery should be the avoidance of any unnecessary loss of blood, for at best, in many cases of brain tumor associated with venous stasis, bleeding is likely to be so excessive as to necessitate postponement of the final steps of the procedure until a second or even a third session.

The common methods of blood-stilling by sponge, clamp, and ligature are largely inapplicable to intracranial surgery, particularly in the presence of bleeding from the nervous tissues themselves, and any device which serves as an aid to hemostasis in these difficult operations will bring a larger number of them to a safe termination at a single sitting, with less loss of blood and less damage to the brain itself.

In addition to the more familiar tourniquet for the scalp, and wax for diploetic and emissary bleeding, suggestions are offered as to the use of gauze pledgets, dry sterile cotton, fragments of raw muscle and other tissues, as well as sections of organizing blood clots for superficial meningeal bleeding, and silver "clips" for inaccessible individual points either in dura or brain.

The successful consummation of any critical operation often depends upon seeming trifles. It is, however, the scrupulous observance of surgical minutiæ that makes possible the safe conduct of major intracranial performances—performances which a few years ago were attended in most cases by a veritable dance Macaber.

EXTIRPATION OF TUMORS OF THE VOMER THROUGH THE ROOF OF THE MOUTH.

By CHARLES H. MAYO, M.D.,
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Tumors of the nasal and nasopharyngeal regions are of common occurrence, but fortunately most of them are benign in character. Adenoids belong to this non-malignant group and occur frequently in children. Later in life the fibromata and the much more numerous polypi are seen.

Many types of operations have been recorded for the removal of malignant diseases in the nose (sarcoma and carcinoma). Nearly all of these operations being purely nasal procedures through the normal openings and peculiarly enough the success of such procedures, often admittedly incomplete in the reported cases, are quite as favorable as regards freedom from recurrence as are the operations for simple tumors performed in the same manner.

Infection following these operations appears to be a factor in delaying recurrence, especially in malignant disease, although many of the cases were reported soon after the operation was completed. Undoubtedly intranasal operations skilfully performed may destroy or remove large tumors which spring from the pharynx, lateral wall, and septum.

There are tumors, endothelial and sarcomatous in structure, which develop in and destroy existing tissue, such as the vomer. No benefit will be derived in these cases from the use of the snare or forceps, which are the instruments commonly employed for the removal of intranasal growths.

The early symptoms manifested by tumors of the vomer are:

nasal obstruction and the consequent changes in the voice. The offensive discharges accompanying malignant disease of the nose are of late occurrence, and when the vomer is involved the discharge does not appear until the structure is destroyed or replaced by ulceration of the diseased growth. Local pain or deafness have not been marked features of these cases.

Abnormal thickness of the septum is noted, and when this extends anteriorly may be mistaken for septal abscess. The pain, elastic touch, and more acute condition of abscess, however, differ from the slower invasion of malignant disease. The posterior enlargement of the septum can be felt with the examining finger, and seen with the reflection in a mirror. One of the reported cases developed a rigid thickening in the roof of the mouth beneath the vomer.

In examining tumors of the vomer the pathologist should insist that the tissue removed for microscopic examination be deep enough to secure real tumor tissue which will show the characteristics of the growth, otherwise the specimen may show but normal, or at most inflammatory mucosa.

Metastasis, as a rule, is a late symptom and when it is present few patients can be improved in health or have their lives prolonged by radical surgery. In such cases the use of Coley's[1] toxins, and in addition the ligation with exsection of the external carotid arteries for starvation of the growth, as advocated by Dawbarn,[2] may prove of some benefit with or without local treatment.

With regard to the benefit to be derived from Coley's toxins: We believe that they are indicated in such cases of nasal malignancy, after the diseased growth has been removed by operation, and not, as has been done so often, reserve the procedure for inoperable cases only, or to wait for a recurrence of the growth. In a few instances excellent results have been reported by injections into the tumor; for example, formalin, arsenic, alcohol, adrenalin, etc.

The methods of approach in removing nasal tumors other than by the anterior or posterior normal openings are as follows:

Displacing the external nose and cartilage upward by an incision within the lip similar to the route advocated by Halstead[3] and

FIG. 1.—Bone removal. Tumors of vomer.

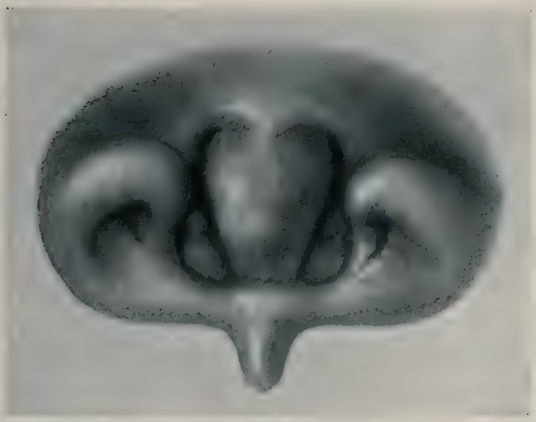

FIG. 2.—Tumor of vomer. Posterior view

Kanavel[4] in the approach to the hypothesis. In order to secure additional room the upper jaws may be divided and separated, to be reunited by wire or splint, as advocated by Gussenbauer[5] for removal of nasopharyngeal growths. Many operations through external incision have been advocated: Lateral incision, turning the nose over to one side, Loewe,[6] horseshoe incision on both sides and across upper bridge, turning the nose down, are some of the methods recommended.

Boeckel's[7] angular incision at the side of the nose, opening the nostril and extending outward beneath the eye, gives good exposure. By extending the incision to the eyebrow past the internal canthus, the operation in converted into that of Moure's,[8] which is of value when more room is desired and is much less mutilating than most operations through an external excision.

In operating through the mouth, Nélaton[9] makes an incision in the midline along the hard and soft palate with resection of the bone. The soft palate is completely divided.

In two cases of malignant disease of the vomer, each with a pear-shaped enlargement of the septum which completely closed the posterior nares, we were able to remove the growth through the roof of the mouth by the removal of a section of the bone one-inch long and three-fourths of an inch wide. In neither of these cases was it necessary to sever the soft palate as advised by Nélaton; a procedure which adds to the technique of the operation and to the after-care of the patient.

In preparation for the operation it is advisable to give the patient 30 to 50 grains of urotropin twenty-four to forty-eight hours preceding the operation, as it undoubtedly aids in preventing meningeal infection. In the two cases which were operated in our clinic at St. Mary's Hospital, the patients were given ether to profound anesthesia following the preliminary hypodermic of $\frac{1}{150}$ grain of scopolamine and $\frac{1}{4}$ grain of morphine, given two hours before operation to secure the full effect of the scopolamine.

The resection of the central posterior half of the hard palate is made by midline incision with preservation of the mucoperi-

osteum and soft tissues. The position of the patient being the reverse Trendelenburg,[6] at this stage of the operation the head of the table is lowered with the head back in the Rose[7] position, which prevents the blood from aspirating into the trachea. The septum is rapidly removed with bone-cutting scissors and curette, and the space packed with gauze. The hemorrhage is quite free during the operation, requiring constant sponging or a sucking apparatus for its removal. The primary gauze pack may be removed within a few minutes and the area of superior attachment of the vomer cauterized with a Pacquelin. The nasal space is then packed with benzoated gauze, which is removed on the third day. According to the extent of the disease, some cases may be treated best by immediate suture of the mucoperiosteum, as in a cleft palate operation; while in others it may seem best to maintain the opening, for a time at least, for observation and treatment. Both of these methods were followed in the cases reported herewith.

Case A 41472. Mrs. H. A. C., aged fifty-six years. Examination July, 1902. Nasal obstruction, and change in voice due to the condition. Diagnosis: Tumor in vomer area. Operation January 29, 1903. Resection of bony palate in roof of mouth. Preservation of soft palate. Removal of vomer. Cautery to area of superior attachment. The opening left for observation was covered by plate with teeth which the patient wore. Pathological report: Sarcoma.

Patient remained well seven years, then died of carcinoma of the ntestines following an illness of several months.

Case A 49321. E. McD., male, aged sixteen years. Examination February 15, 1911. For five months has had discharge from the nose with obstruction. Tumor occupying vomer area. Diagnosis: Sarcoma of septum. Operation February 25, 1911. Removal of tumor through roof of the mouth. Bony resection with preservation of soft palate. Pathological report: Fibrosarcoma.

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THE TREATMENT OF FAR-ADVANCED MALIGNANT DISEASE.

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PHILADELPHIA.

One of the most perplexing and pathetic questions which confronts the surgeon is what to do for patients suffering from far-advanced malignant disease. We realize that the results obtained by early and radical operation are gratifying, and that it is only by such treatment cures can be accomplished. It is obvious then that what we want is to have the patients come to us early and not as a last resort. Why do they not come early and why do they so often first consult the cancer quack? (I refer, of course, more particularly to the more ignorant class of patients, though such behavior is by no means rare among patients who consider themselves intelligent.) In order to answer this question I have asked many patients to explain their delay and their obvious dodging of the surgeon, and I have discovered that there is a widespread belief among the laity that surgery is of no avail in the face of cancer, and that it should only be employed when other means of treatment have failed. Probably in no surgeon's office, and certainly in no surgical dispensary, is the following statement rare: "If it is a cancer, I do not want it operated on; but if it is a simple tumor, I am willing to have it removed." On being asked to explain his attitude, the patient tells us that he knows of several cases, often one or two in his own family, where recurrence took place promptly after operation. He does not understand that the operation was probably a late one, and draws his conclusions only from the

result accomplished by the operation. Unfortunately the patient sometimes gets bad advice from his medical attendant, who lacks courage enough to say as soon as the growth is discovered that a surgeon should be consulted, and wastes valuable time in applying ointments and giving placebos. Many general practitioners share the belief I have accredited to the laity that surgery is of no avail in the treatment of malignant growths, and this belief has its origin in the contemplation of early recurrences after late and incomplete operations. These practitioners are often forced by their own consciences or by the importunities of the patient to bring him for operation when the disease has advanced beyond relief. There can be no doubt whatever that this want of faith in surgery is prevalent in the laity, and to a small extent in the profession; nor is there any doubt in my mind that it has its origin in the knowledge of the results obtained by operation in far-advanced cases. It seems to me, therefore, that as surgeons it is our duty to correct this false impression and substitute for it the truth, which is that cancer is curable if accessible and if operated upon early and thoroughly. Many will say that we are certainly preaching this, and I admit it; but our practice very often counteracts the effects of our preaching. A poor patient presents herself, or is brought by her physician, with a far-advanced cancer of the breast with extensive glandular involvement, a condition which we recognize as being beyond operative relief; but out of sympathy for the sufferer, or with the vague hope that operation may relieve suffering or perhaps prolong life, or because the physician has told the patient she must be operated upon and persuaded her to consent, we operate, doing a most extensive removal of the original growth, but finding too often that the glandular involvement is beyond removal, or worse, and that metastasis to some other inaccessible part has already occurred. What is the result in such a case? The patient recovers from the operation, goes home, thinks she is cured, and she and her friends spread the news that she has been operated upon. In a few months the disease has killed her, and all her friends and acquaintances make the natural

deduction that surgery cannot cure cancer. When one of these develops a similar condition, operation is postponed until the same hopeless stage is reached, and then operation is sought as a last resort. This, I take it, is the wrong way to teach the laity what surgery can do, and thwarts our object—namely, that of getting the cases early.

Let us, for example, take this same type of case again, and say honestly to the patient or her family and to her physician that the disease has progressed too far for operation. What will be the effect on the physician and on his patient of such an attitude? On the physician, if he is conscientious and honest, it will be that of stimulating him to bring his cases of tumor to us at an earlier date. The patient and her friends spread the news that she applied too late for operation, and she succumbs to the disease possibly a little earlier than if she had been operated upon. But the effect upon her circle of acquaintances is that when one of them develops a similar growth she will hasten to the surgeon, lest she, too, may be told that the disease is beyond any hope of surgical relief. The public must be taught, and this is one way we can do it. It will be said that by this plan we are arbitrarily sacrificing the individual for the benefit of the race, because we cannot say how far the disease has advanced until we operate, and that occasionally cures are accomplished when least expected. I believe that with careful physical examination and thorough study of statistics we can pick out the cases which are apt to give us the pleasant surprises. We all realize that there are certain types of malignant tumor which grow slowly and metastasize late, and in such, even if far advanced, cure or a long period of freedom from disease may be accomplished. But these are not the cases I would reject. On the other hand, we have types of carcinoma, like that of the uterus and the rectum, especially in young people, where only early operation can be of avail. An examination of the liver through an abdominal incision has more than once saved me the chagrin of resecting a rectum for cancer when the liver was already extensively involved in the disease. We know that a

slow-growing cancer of the breast in a woman past fifty years of age, even if the skin is extensively involved, gives often a fair operative result; and we know equally well that it is useless to operate on a far-advanced rapidly growing breast cancer in a young woman.

My feeling in regard to this matter is that, for extent and thoroughness, operations for cancer have reached their limit, and our improvement in the treatment of this disease must come through impressing the public and the profession with the idea that malignant disease must be attacked early and radically if it is to be treated successfully, and that one of the ways of doing this is to avoid operation, except those of absolute necessity, in cases which our experience and judgment tell us are so far advanced that there is only a small hope of temporary relief. By declining operation in the hopeless cases we stimulate those physicians who refer their patients to us to greater effort at early diagnosis, and we impress the laity with the fact that it is early operation which cures cancer. To operate upon a far-advanced cancer of the rectum, with probable hepatic metastasis, means an early death accredited to futile surgery; while to turn such a case down with the statement that it is too late, throws the onus where it may rightly belong—on the patient himself or on the physician who may have been giving him his "favorite pile ointment" without having once examined the interior of the rectum. In how many cases of cancer of the rectum do we find that a recent operation for hemorrhoids has been done?

Improvement in the treatment of these cases of far-advanced malignant disease must come, it seems to me, by early and complete operation, and not by carrying our already extensive operative procedures still farther. The following is an illustration of the point I would make, and I am sure it can be duplicated in the experience of most of my hearers. Last winter I was foolish enough, out of sympathy for the patient and because of the importunities of the husband, to operate on a rapidly growing adenocarcinoma of the breast, which for six weeks had been daily "rubbed" by an osteopath,

who told the patient that although the treatment might not cure her it would put the parts in better condition for operation later. When I first saw her it looked as if the breast were the seat of an enormous abscess, and the axillary and cervical glands were extensively involved. The suffering and distress were so great that I yielded to the hope that an extensive operation followed by *x*-ray treatments might, at least, relieve the suffering. Recurrence took place in three or four months, and the patient died in six or eight months. How many of the acquaintances of this poor woman do you think believe that she died because "surgery cannot cure cancer?" How many do you suppose know of the previous treatment, and would not my refusing to operate, because of the previous mal-treatment, probably have had a restraining effect in the future on the person administering it?

In checking fire, dynamiting and counterfiring may be of avail sometimes; but the surest way is to put out the fire in the beginning, and the same applies to the treatment of cancer.

PERFORATING BULLET WOUNDS OF THE FEMORAL ARTERY AND VEIN RESULTING IN ANEURYSMAL VARIX; TWO WOUNDS IN EACH VESSEL CLOSED BY SUTURES; RECOVERY.

By GEORGE TULLY VAUGHAN, M.D.,
WASHINGTON, D. C.

There was admitted to Georgetown University Hospital, October 6, 1910, a white male, W. C., aged eighteen years, having just been shot, a 0.32 pistol ball having entered the front of the right thigh over the femoral vessels about three inches below Poupart's ligament and lodged beneath the skin of the gluteal region one inch external to the tuberosity of the ischium.

There was severe hemorrhage at once, which was arrested by a physician, who happened to be near, stuffing a portion of a handkerchief into the wound. At the hospital the handkerchief was removed and sterile gauze was put in its place.

There was no further bleeding, and four days later the ball was removed under local anesthesia.

The patient was kept in bed until the wounds had healed, about two weeks, when signs of aneurysm appeared, a thrill on palpation, and a bruit, which was heard both above and below the wound.

A diagnosis of aneurysmal varix was made and operation was done eighteen days after the receipt of the wound. A longitudinal incision was made over the femoral vessels through the bullet wound, and the tissues were carefully separated until the vessels were exposed over a distance of about three inches. In

order to control the flow of blood both vein and artery were gently clamped with rubber-padded forceps above and below the site of injury. No clots were found, but the vein and artery were firmly united to each other and were separated with great difficulty and considerable hemorrhage. The ball had passed through the artery and vein below the origin of the profunda, where the vein passed beneath the artery, and not through the middle, but nearer the inner border of the vessels. The anterior opening in the artery and the posterior opening in the vein were closed with lymph, which was easily detached, and the four openings were then sutured with fine silk soaked in vaseline, using the continuous stitch through all the coats of the vessels. The line of suture was longitudinal, and the result was that each vessel was reduced to about one-third of its original size. The padded forceps were removed and a few additional sutures were used until all bleeding was controlled. Before closing the wound the artery was seen pulsating below the site of the operation.

October 25. Patient doing well, the extremity is warm and of good color, but no pulsation can be felt either in the anterior or posterior tibial.

October 26. Pulsation is felt in posterior tibial at the ankle-joint.

November 4. Pulsation distinctly felt in the femoral artery just below the wound. This was the first time the pulsation was sought at this point, owing to the presence of the dressings.

November 14. Discharged recovered. Pulsations distinct in both tibials and in the femoral just below the wound, but weaker than normal.

The questions for consideration in the case of this patient were whether to ligate the femoral artery above and below the wounds, to resect the injured portions and make an end-to-end anastomosis, or to suture the openings in each vessel. The first suggestion was abandoned, as it would have obliterated the artery; the second was also abandoned, because it was thought to be more difficult and more hazardous than the method which was adopted.

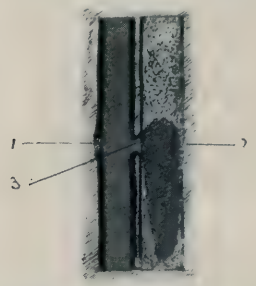


FIG. 1.—Lateral view: 1, wound of anterior wall of artery; 2, wound of posterior wall of vein; 3, communication between artery and vein.

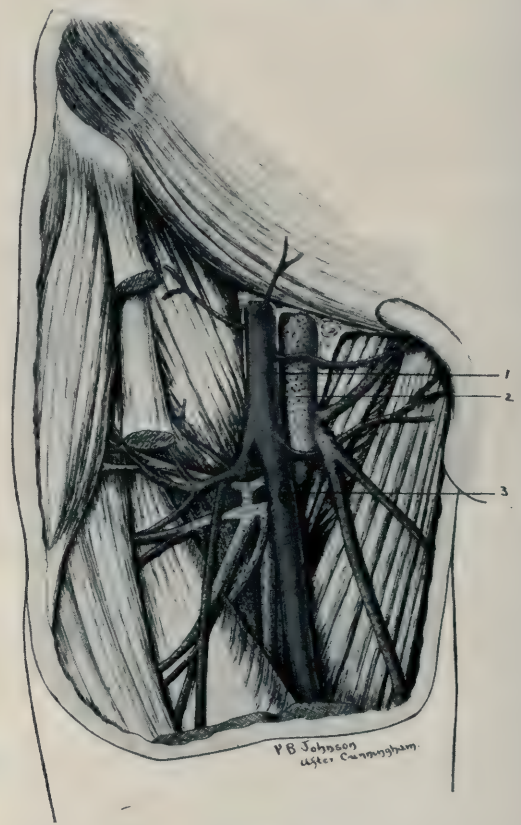


FIG 2.—1, femoral artery; 2, femoral vein; 3, wound in anterior wall of artery.

While it is probable that ligation of the femoral artery would have resulted in the establishment of good collateral circulation, it was better and safer for the patient's leg to preserve the vessels.

It has been said in its favor, as compared with other aneurysmal conditions, that aneurysmal varix is of slow growth, rarely attains large dimensions, has no tendency to form clots, and is not likely to rupture. I cannot say as to the other points, but I have seen two cases in which the sac has attained very large size, being composed of the dilated vein with capacity of about 1000 cubic centimeters. Not only does the vein become varicose in its branches, but dilatation also takes place on the proximal side of the communication with the artery. In the two cases mentioned the maximum dilatation was on the proximal side, as if the vein were subjected to the pressure both of the arterial and venous currents; but the venous current predominates, and has the power to carry the dilating forces along with its current and away from the direction of the arterial current. I have discussed this question more fully in the TRANSACTIONS of the Association for 1907. The accompanying drawings give a better idea of the wounds.

SALT SOLUTION AS A FILLING FOR BONE CAVITIES AND FOR VACANT SPACES IN THE HARD AND SOFT TISSUES.

By HARRY M. SHERMAN, M.D.,
SAN FRANCISCO, CALIFORNIA.

The present day method of closing wounds, surgical wounds at all events, by sutures in tiers, so that an anatomical continuity of individual tissues is restored and no vacant spaces are left, meets with an obstacle when we have to deal with the one rigid tissue in the body, bone. Even wounds of the bone which are in its superficial portions can be made to conform to the requirement of leaving no vacant space, the elasticity or flaccidity of contiguous soft tissues enabling them to be approximated to or pressed into the bone wounds to close them. Wounds of the bone which are so deep that they pass through the cortex and enter the medulla or cancellous tissue do not permit of this complete closure; a vacant space must be left which can be healed only by a process of granulation-tissue formation. The problem presented has been, and is, to discover a method of treatment which will permit the anatomical closure of the wound in the soft parts and its prompt healing, leaving conditions in the bone wound which will preclude sepsis and permit or favor granulation-tissue formation. Evidently the space in the bone must be filled by some substance which will, primarily, exclude air and infection, and which will, secondarily, be absorbable, so as to be removed as granulation-tissue formation or osteogenesis progresses.

Various substances have been proposed and used for this purpose. Schede, in 1886, described a special method of using moist blood clot, but the technique did not conform in all the details with the requirements as just stated, in that the blood

clot reached to and was exposed at the surface of the skin in many instances. Here it was covered, in strict conformity with the antiseptic method of time, by Lister's protective oiled silk, but, as we now know, this does not prevent infection from the contiguous skin, and while in many cases a fortunate technique secured a satisfactory healing, in many others the blood clot itself became a means of permitting a superficial infection to extend to the deeper parts, so that the whole of the bone wound was again affected. For these reasons the method failed to be generally adopted.

Senn, in 1889, suggested and used decalcified chips of ox bone which were impregnated with corrosive sublimate after the removal of the lime salts. With these the wound cavity in the bone, which had been well washed out with antiseptics, was filled, and with them was put a certain quantity of iodoform powder. Over this filling the soft parts were closed, an absorbable capillary drain being used. The method had successes, chiefly in the hands of the originator, but in some instances the ox bone overtaxed the absorptive powers of the patient, in others the antiseptic character given to the chips by the corrosive sublimate failed to control residual infection or else itself interfered with absorption, and in others again the presence of an absorbable drain was a fault in technique, as it led superficial infection to the deeper parts and rendered the extrusion or removal of the bone chips inevitable. For these reasons this method, too, was found to be not generally applicable, and so has fallen into disuse.

In 1903 Fantino and Valan advocated calcined bone for filling the cavities of bone wounds. They advanced the remarkable theory that it was necessary to furnish locally the bone salts for the regeneration of bone. In cases of aseptic bone wounds they filled them at once with the calcined bone and sutured the soft parts over them. In cavities potentially septic they added to the calcined bone iodoform and thymol, in the proportion of three parts of calcined bone, two parts of iodoform, and one of thymol. These made at 75° C. a paste which solidifies at 60° C.

This mass was more slowly absorbed than was the calcined bone alone. Bone wounds which were frankly septic they filled with a 10 per cent. iodoform and glycerine mixture, which they heated by putting the thermocautery into the fluid, for the purpose of sterilizing the tissues. They reported successes—23 cases out of 30 healing satisfactorily, but I do not know of others who have tried the method except Huntington, who has had one success and some failures.

In 1906 was reported Mosetig Moorhoff's well-known filling of iodoform 60 parts, spermaceti 40 parts, and oil of sesame 40 parts. The technique of the operation included the removal of the infected or necrotic bone, the drying of the cavity with hot air and filling it with the mixture mentioned, which was poured in melted and fluid, and then hardened in the cavity. Over it the soft parts could be sutured. Radiograms in series show the gradual disappearance of the wax and the development of bone.

This method has been extensively followed with varying measures of success, but never with the successes claimed by the originator unless it be in the surgical clinic in the University of Minnesota. Healing of the soft parts seems not difficult of attainment, but absorption of the mass of filling is often not accomplished, and it is gradually extruded as granulation tissue is developed in the bone wound.

In these three last mentioned methods—Senn's, Fantine and Valan's, and Mosetig Moorhoff's—iodoform has played a large part in the filling material. Iodoform is said to be an inhibitor of microbic life, but it is not an antiseptic. In the mixture it might be considered as preparing the residual pyogens for phagocytic removal, a sort of chemical opsonin, but unless it does this its value in the mixture is debatable. For the rest divergent selections were made. Senn used that part of bone that Fantino and Valan rejected, and they used what Senn rejected. Mosetig Moorhoff adopted a bland mixture of oils with a low melting point, so that they might be poured into the wound while fluid, fill every nook and irregular corner, and then

solidify, to exclude all air and maintain the hemostasis secured by the drying of the cavity.

All of these methods left in the bone wound, frequently in cavities potentially infected, what the tissues commonly treated as a foreign body, and if they could not absorb it they rejected it, and in doing the last they had to maintain a sinus as an avenue of exit for the fragments of filling that were detached. Normal healing, healing by first intention, with permanence of the result has not been the rule.

There is one more filling to be added to the list. In 1908 Emil Beck reported his discovery that an ointment made of bismuth and vaseline injected into tuberculous sinuses—primarily for radiographic representation of the sinus ramifications—often was not extruded, but that instead the sinus healed readily and quickly. Many surgeons adopted the plan and verified Beck's findings and the bismuth ointment became, and still is, a popular material for the filling of all cavities from those of a bone abscess to that of an old empyema. Leaving all other considerations aside it is to be emphasized here only that bismuth and vaseline are both foreign bodies, that vaseline is readily disposed of and bismuth is disposed of with difficulty, and that in not a few instances it has acted as had the materials selected by Senn, Fantino and Valan, and Mosetig Moorhoff.

Some years ago, in doing an operation for the removal of the Gasserian ganglion, I wounded the dura mater and had to suffer, during the operation, from the annoying leakage of cerebrospinal fluid. When it came time to close the wound the squeezed-up brain in the collapsed sac of the dura mater did not readily expand to fill the space within the skull. In order to avoid leaving a large amount of air in the wound, I poured in sterile physiological salt solution, and sutured the scalp over it. The wound healed normally and the patient recovered uneventfully. Since then I have used salt solution to fill all cavities or spaces that could not be closed by suture, except that I have not used it in cavities or spaces that were actually or potentially septic. This has, I know, given the plan a limited application; but within

that limitation it has been used in cases that would otherwise have been the recipients of some one of the fillings just mentioned, and in one instance it was used successfully after one of the mentioned fillings had to be removed.

FIG. 1.—Three days after the second fracture, showing extension of bismuth paste into soft tissues and the line of the fracture.

I report the following cases as illustrations:

CASES I to IV.—In four instances children presenting themselves with the symptoms and signs of hip-joint tuberculosis were shown by radiogram to have localized tuberculous foci or abscesses in the diaphysial portion of the femoral neck. In these instances I have opened the trochanter by a trephine, extended the wound to the abscess, have cleaned it out and

removed the softened bone around it, and then filled the cavity with physiological salt solution and sutured the fascia and integument over the bone wound. In one instance I got normal healing, which was permanent, the tuberculous process stopped, and the child made a relatively quick and complete recovery which has been permanent for four years. In two instances I got

FIG. 2.—First radiogram out of the splint after the operation. A small drop of bismuth paste left in the bone. Union firm.

normal healing, but the tuberculosis was not controlled and the cases followed the usual course of a hip-joint tuberculosis, not benefited by the operation. In the fourth instance I got normal healing and the child returned home in a plaster-of-Paris spica. Within a month after the operation an acute pneumonia developed and caused death. I secured the head, neck, and trochanter, upon which I had operated. The wound cavity I had made in

the trochanter and neck was filled by a layer of granulation tissue with a blood clot, apparently undergoing absorption in the centre. Nothing beyond a macroscopic examination was secured, for the specimen was burned in my office and so never reached the pathological laboratory.

FIG. 3.—Final radiogram apparently showing completion of ossification.

CASE V.—A young man had had a chronic infection in the lower end of the femoral diaphysis for which an operation had been done with apparent success. After a few months the symptoms recurred and he came into my care. A radiogram showed rarified places in the cancellous tissues, and an incision through the cortex opened up two regions of osteoporotic bone, but showed no septic nor tuberculous infection. These osteoporotic regions had fairly well sclerosed bone about them. I

removed the osteoporotic bone, filled the wound cavities with salt solution, and sutured the soft tissues in anatomical layers. There was normal healing and prompt restoration of function which has been permanent. Since the operation the patient has broken the patella of the same leg. I sutured it by Stimson's method and it has healed, and the leg is again in commission. A pathological study of the osteoporotic bone removed showed no pathogens, it being probably a burnt-out focus of a low grade of infection.

CASE VI.—A young man had, after typhoid fever, a series of abscesses in the lower part of the left thigh. These were incised and each healed readily, but the constant recurrence indicated a deeper focus. There was a tender point over the inner femoral condyle. I exposed this by an incision which had to be an extension of an existing sinus. A trephine opening was made in the cortex, soft bone was found beneath and removed. The bone wound was filled with salt solution, the periosteum and the soft parts were sutured anatomically and the sinus was packed with camphor phenol gauze. The bone wound healed normally and has remained healed. The sinus healed by granulation. No more abscesses have formed. No pathogens of any kind have ever been found in the pus from these abscesses, but the man had a Widal reaction and has had injections of the typhobacterins with sequent reactions, and his general as well as local condition has improved as his tolerance of these injections has developed.

CASE VII.—A youth had a fracture of the left humerus at the junction of the upper and middle thirds from a minor amount of indirect violence. The examination of the arm showed that the fracture had occurred through a bone cyst. This was opened, scraped out, filled with the bismuth and vaseline ointment, the wounds were closed, and the arm put into a splint. All healed normally, but in a few months the arm broke again. He then was sent to me, a radiogram showed the bone cyst to be larger than at first, the bismuth ointment occupied its upper part, the bone had broken at the line of the first fracture. I again opened the cyst, removed the bismuth, scraped out the cavity,

filled it with salt solution, interlocked the bone fragments, and closed the soft tissue wounds. Healing was normal in all tissues, and I here present a series of radiograms showing an osteogenesis through the whole cavity extent, except where a small portion of the bismuth was overlooked and left behind.

CASE VIII.—A little child had a large chronic subfascial abscess in one thigh, and a radiogram showed its origin in a bone abscess in the lower part of the femoral diaphysis. Clinically and by inoculation the condition was a tuberculosis. Incisions emptied the abscess in the soft parts and exposed that in the bone. Soft bone was cut from the abscess walls until sound tissue was reached. An extensive layer of the so-called "pyogenic membrane" was removed from the subfascial abscess. The whole wound was washed out with salt solution and the walls scrubbed with gauze wet in the same. Both abscesses were then filled with salt solution and the incisions were closed. Healing was normal. At present, a month after the operation, the thigh, though thick, is firm; there is no local or general fever, no pain is complained of, but the limb is still in a plaster-of-Paris splint, and the result is not yet an assured one.

In the bones these cases represent active tuberculosis and probably typhoid infections and also sterile conditions. In no case has the technique been more difficult than any incision into soft parts which heals readily and normally after suture. In the specimen which I secured from the child who died of pneumonia and in another instance in which I had, for a surgical reason, to reopen the wound, the salt solution has been found to have been replaced by blood clot.

The method is, then, a reversion to Schede's filling, but with an improved technique, in that the wound is not closed before the removal of the Esmarch tourniquet, nor is a drainage arranged for. Instead of this hemostasis is secured in the usual way, then the bone wound is filled with the salt solution, and the soft tissues are sutured closely with no drainage. In all instances so far healing has been normal and permanent. As the salt solution is not an antiseptic, I have not dared to try the plan in a septic wound.

OBSTRUCTION OF THE ILEUM BY A LARGE GALLSTONE; ENTEROSTOMY; SUBSEQUENT CHOLECYSTECTOMY AND SUTURE OF DUODENUM.

By F. B. LUND, M.D.,
BOSTON.

The following case is reported on account of the interest of the surgical problem presented—namely, the obstruction of the lower ileum by a large gallstone which had reached the intestine by an anastomosis between the gall-bladder and the duodenum, and the fact that at the time of the operation another large gallstone was felt in the gall-bladder. The patient seemed too ill to make it safe to prolong the operation for the removal of these stones, and we waited three weeks, fearing all the time that this second large stone might slip into the intestine and cause a recurrence of the obstructive symptoms. At the end of the three weeks the gall-bladder was successfully separated from the duodenum and removed and the large opening in the duodenum closed by transverse sutures. She made an uninterrupted recovery.

The patient, Mrs. L., a thin, delicate woman, aged forty-five years, had suffered four years ago from an attack of abdominal pain and vomiting without jaundice. The illness was severe enough to keep her in bed for two months. Previous to this she had suffered from indefinite pains in her right side, and more or less bloating when tired. Ever since the attack four years ago she had remained rather thin and weak. Again, two years ago, she had an attack of pain in the right hypochondrium which would begin under the right ribs and work across the abdomen

with much gas and pressure. She was so tender that she could not bear to be touched. Constipation was very severe. We had, therefore, the history of two severe attacks of pain upon which the diagnosis of gallstones might very well be made. At the time I saw her, in consultation with Drs. Dewis and Cunningham, she had been attacked, while visiting a friend, with pain in the right upper quadrant. The pain was not so severe that she felt obliged to go home, although she did not eat anything all day. Toward evening her husband took her home, the pain then being very severe. She vomited that night and all the next day. The pain became worse and gradually moved from the right to the left side of the abdomen. She was unable to have a movement of the bowels with an enema. The third day she vomited less, and the day I saw her, which was the fourth day, about six in the evening, she had not vomited at all, but was nauseated and had had no movement of the bowels.

Examination showed a very frail, delicate woman, rather anemic, abdominal walls thin, abdomen markedly distended, and distinct visible peristalsis. In the right iliac region a very tense coil could be felt. There was very little tenderness over the abdomen and no muscular spasm. I saw her at 6 P.M., when she was removed to the Bay State Hospital, and I operated that same evening. Rectal examination showed a rectum ballooned and empty. The tongue was dry, and she looked quite ill. The diagnosis was intestinal obstruction probably by a band, although the gradual onset of the pain did not seem exactly consistent with this diagnosis. It seems to me that a careful study of the previous history combined with the gradual onset of the pain might have suggested intestinal obstruction by a gallstone. A very interesting part of the history to me was that the pain began in the upper right quadrant and then went across to the left, probably as this large stone travelled across the duodenum and through the upper coils of the ileum in the left side of the abdominal cavity. At the operation, which was performed at 8 P.M. the fourth day, I found the upper three-fourths of the small intestine very much dilated and reddened. There was a large

amount of free fluid in the peritoneal cavity. In the lower quarter of the small intestine there was a very large stone entirely blocking the bowel, which below the stone was much contracted and ribbon-like. The stone was firmly grasped by the intestinal muscle, and could with difficulty be pushed back. The intestine was incised and the stone removed. All the small intestine above the stone was then strung on a three-foot long Monk's tube and thus easily

FIG. 1.—Stone removed from intestine. Photograph by Dr. Dewis. Natural size.

emptied of its contents. There was then ecchymosis on the intestine. Part of it was very dark in color. The incision in the intestine was closed with double Lembert sutures. The gall-bladder was examined and found to be in anastomosis with the duodenum. The gall-bladder was felt to contain a large stone and one or two others. Although it was felt that these stones might drop into the duodenum at any time, progress into the ileum, and cause obstruction, it was decided best to take the chances on account of her poor

condition, and not attempt to remove it at present. It was felt that the gall-bladder had so relaxed by the expulsion of this first large stone that probably it would not contract sufficiently to expel the other into the duodenum. The patient did well except for a stitch abscess in the abdominal wound. During the next three weeks there was tenderness over the gall-bladder and muscular spasm. She suffered somewhat from pain.

FIG. 2.—Stones removed with gall-bladder at second operation. Photograph by Dr. Dewis. Natural size.

On March 28 an upper right rectus incision was made and the gall-bladder found buried in adhesions. On dissecting it out it was found to contain two stones, one of them quite large, about half the size of the one removed at the previous operation. On opening the gall-bladder the larger stone was found to lie against a very large hole leading into the duodenum, which would easily take two of my fingers. There was no bile in the gall-bladder, which was firmly contracted about these two large stones. With

considerable difficulty it was dissected free from the duodenum and removed. The adhesions, both old and new, made this a

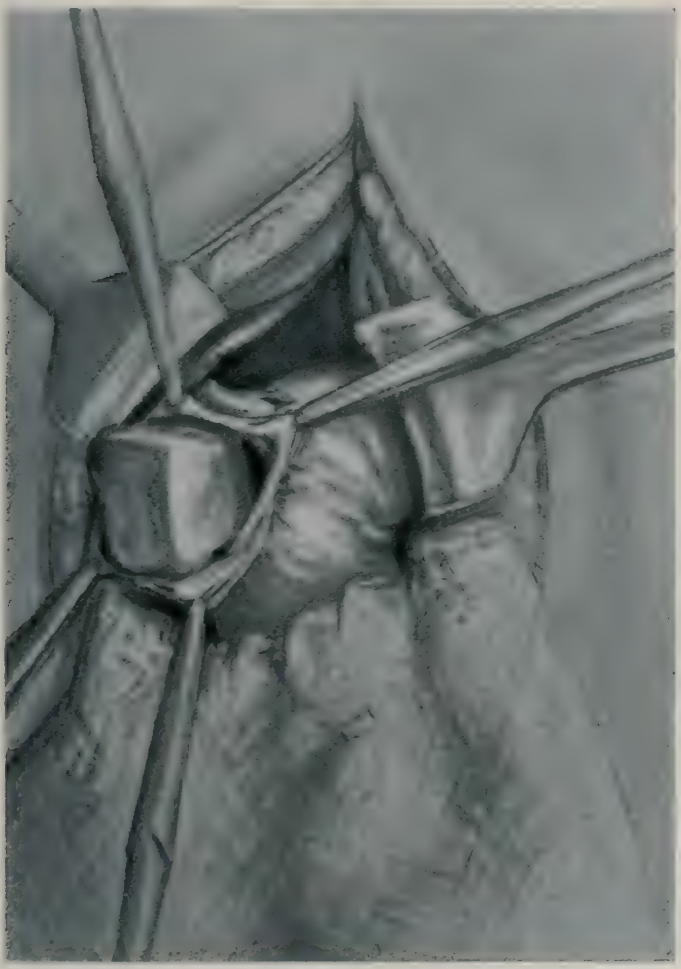


FIG. 3.—Sketch of removal of stones of gall-bladder in anastomosis with duodenum.

difficult proceeding, especially on the under side. The opening in the duodenum was then sutured transversely with continuous Connell sutures of catgut reinforced by interrupted Lembert

linen sutures. The patient bore the proceeding well and has made an excellent recovery, and is now in good condition.

FIG. 4.—Duodenum sutured and stump of gall-bladder tied.

The very large size of these gallstones is interesting. They must have remained there a long time, it seems to me, before they caused any symptoms at all.

The perforation of the gall-bladder into the duodenum, I think, must have occurred during the second attack, in 1909, as the account of this illness reads like a severe attack of local peritonitis. This large stone probably had lain against that opening ever since, which had been gradually enlarged as the contraction of the gall-bladder forced the stone against it until, four days before I saw her, it was squeezed through and went on its way to obstruction.

Acute obstructions of the ileum by bands are usually due to pelvic peritonitis and follow operations upon the pelvic organs or appendix. Since the gall-bladder is situated between the liver and colon, adhesions which are due to these inflammatory conditions rarely involve the small intestine or cause acute obstruction thereof. Cases of obstruction by bands are very common. Cases of obstruction by enteroliths have been very rare in the writer's experience. It was in the hope that the history of this case might throw some light on the diagnosis in future cases that this case was reported.

The commonest cause of obstruction with which we have to deal is obstruction by bands. These bands usually occur in the pelvis, either from disease of the female pelvic organs or from appendicitis, and involve the small intestine, causing strangulation and kinks. Peritonitis due to gall-bladder disease rarely causes intestinal obstruction, because the gall-bladder is hidden behind the large intestine, between it and the liver, and can with difficulty become tied to the mobile small intestine. Therefore, intestinal obstruction by bands ought to be, and is, rare after a definite history of disease of the gall-bladder. It is also true that the onset of intestinal obstruction by bands is more acute and the progress of the disease more rapid than in the case of obstruction by an enterolith. In the case here reported the pain at onset was not severe enough to keep the patient from continuing at her work of sewing for eight or ten hours. The gradual change of location of the pain was suggestive of the change of position of the enterolith, and the time when the symptoms became severe enough to lead to a

surgeon being called was four days later. It would therefore seem possible in another case of this sort to make a correct diagnosis of obstruction by enterolith instead of the erroneous diagnosis of obstruction by a band, based (*a*) on the previous history of gall-bladder disease suggesting enterolith; (*b*) on the gradual, instead of sudden, onset and slow progress of the symptoms.

SUBCUTANEOUS INJECTION OF NORMAL HUMAN BLOOD SERUM TO PREVENT AND OVERCOME POSTOPERATIVE HEMORRHAGE IN PATIENTS WITH CHRONIC JAUNDICE.

By WILLY MEYER, M.D.,
NEW YORK.

In May, 1910, I had the privilege of listening to a preliminary report on the effect of subcutaneous injection of normal human blood serum upon hemophilia neonatorum, by Dr. John E. Welch, at that time pathologist of the New York Lying-in Hospital.

The subject was of intense interest to me. Dr. Welch stated that he had cured by this method every one of 12 babies afflicted with hemophilia neonatorum; whereas of 18 other cases treated in the old way by drugs, such as calcium salts, gelatin, adrenalin, etc., 17 had died.

During the reading of the paper it occurred to me, as I am sure it did to others in the audience, that this method of treatment might be of value also in diseases of adults associated with hemorrhage, and I was glad to hear Dr. Welch express himself to that effect in the course of his paper.

It was the cases of uncontrollable hemorrhage following operations on the bile ducts in the presence of chronic jaundice that were principally in my mind. Up to date we have but unsatisfactory means of dealing with this often fatal condition. It represents the crux in the surgery of the bile system.

At the close of the meeting I had the opportunity of discussing the question with Dr. Welch, and he very courteously volunteered to procure the serum for me as soon as a suitable case should present. It came not long after.

CASE I. *Chronic Jaundice Due to the Presence of a Malignant Tumor of the Pancreas.*—On June 20, 1910, a man, aged forty years, entered the surgical division of the German Hospital with most pronounced jaundice; it had appeared gradually, without colics; his skin had a bronze color; stools without a trace of bile; a resistance was palpable in the epigastrium. Diagnosis: Malignant tumor, probably of the pancreas, compressing the papilla Vateri. Knowing that the tendency to hemorrhage in patients suffering from cholemia is due to the condition of the blood, and not to any of the manipulations that may become necessary in the course of operation, it seemed wise to make use of the subcutaneous injections of normal blood serum *before* operation, as a prophylactic, rather than wait until a hemorrhage should set in, when it might be too late. Through the kindness of Dr. Welch, a supply of serum was provided by tapping the cephalic vein of a healthy individual in the ward, and of one of the patient's relatives. Dr. Welch's apparatus, as described in the *American Journal of the Medical Sciences*, June, 1910, was used. Unfortunately, the needle became plugged when withdrawing the blood from the second patient, thus the amount of serum available was not large. On the day before the operation the patient received 30 c.c. (1 ounce) three times, and 15 c.c. ($\frac{1}{2}$ ounce) just before operation, June 25. With the help of the rectus incision a malignant pancreatic tumor was palpated, and a typical cholecystenterostomy done with needle and thread, selecting the uppermost coil of the jejunum for the anastomosis. All vessels, even the smallest, were carefully ligated. Soon after the work was finished, another ounce of the serum was given hypodermically. The first three days after the operation passed nicely. In the morning of June 29 (the fourth day), sudden collapse; temperature, 104°; no signs of peritonitis. A few hours later, tarry stools, corroborating suspicion of intestinal hemorrhage. Serum injections immediately resumed. June 30 and July 1, three injections of serum, 30 c.c. (1 ounce) each; July 2, two injections of same amount, with the result that no further bleeding occurred, and the patient went on to

recovery. Discharged July 8; no jaundice; colored stools. Succumbed to the carcinoma three months later, hemorrhages never having returned.

CASE II.—Female, aged fifty-three years. June 20, 1910. Chronic jaundice; prophylactic injection of serum for two days (150 c.c. (5 ounces) in all); laparotomy; cancer of common duct; cholecystostomy; no hemorrhage.

CASE III.—N. Z., female; aged fifty-two years; seen in consultation with Dr. M. Rehling; profound jaundice; no colics at any time; prophylactic serum treatment, 90 c.c. in all (3 x 30 c.c. on day before operation); laparotomy (Dr. Rehling) June 25; cancer of pancreas; drainage of gall-bladder; 45 c.c. of serum after operation; no hemorrhage. Died one month later from asthenia.

CASE IV.—E. S., female, aged fifty-four years; admitted to private hospital October 30, 1910; chronic jaundice, without colic; intense itching; hard, tender tumor palpable under right costal arch. Diagnosis: Chronic cholecystitis with stones; probably carcinoma. Prophylactic serum injections for two days (150 c.c. (5 ounces) in all); November 7, laparotomy; carcinoma involving entire length of hepatic and common duct encroaching on cystic; gall-bladder thickened, whitish; two large stones; chronic hydrops. Radical operation impossible; cholecystectomy; hepaticus drainage. November 8 twice, 30 c.c. (1 ounce) of serum. Death December 14, from cholangitis; no hemorrhage at any time.

By a peculiar coincidence the jaundice in all of the four cases reported was due to carcinoma. In none did any parenchymatous hemorrhage occur after the prophylactic and postoperatively resumed injections of normal human blood serum, although it is just in these cases that this grave complication is so frequently seen. This non-occurrence of postoperative hemorrhage in 3 of the 4 cases reported should invite further trials of the new method. The favorable outcome in the first case certainly is remarkable. After the preliminary injection of a total of 105 c.c. ($3\frac{1}{2}$ ounces) of normal human blood serum,

no more being on hand, and 30 c.c. directly after the operation, a severe intestinal hemorrhage set in ninety hours after operation; patient's condition desperate. Under resumed serum treatment the fever soon drops, bleeding ceases permanently, and patient recovers.

I have no doubt that similar favorable observations will be made with Welch's injections in cases with jaundice due to obstructing stones in the common duct. It certainly would seem improbable that the treatment should have a different effect in cholemia due to stones than in that caused by carcinoma. Personally, I have had no chance to try it in such cases.

The injections should be started at least two days before operation, 30 to 60 c.c. (1 to 2 ounces) to be administered three times per day, and should be continued right after operation for another forty-eight to seventy-two hours. It is wise to provide for the serum in time; both cephalics of two healthy individuals should be tapped; they will yield from 300 to 400 c.c. (10 to 14 ounces) of serum. Wassermann's reaction should, of course, be made; it does not seem of great importance, according to my observations, to test and follow up the coagulation time of the blood, although the latter appeared repeatedly reduced in course of the serum treatment. If useful subjects are not available among the relatives of the patient, an advertisement in the daily papers will usually place the serologist of the hospital in possession, for a small consideration, of all the blood serum required.

That cases in which the injections of normal human blood serum are given *after* the onset of a hemorrhage following an operation on the bile ducts in the presence of chronic jaundice do not respond as well to this new method seems to be corroborated by an experience of Dr. F. Torek's, attending surgeon to the German Hospital, which I here report with his kind permission:

Mrs. P. S., aged thirty-six years; icteric for four months. Diagnosis: Stone in common duct. Calcium chloride given

before operation; gall-bladder found to contain stones. November 24, 1910, cholecystectomy and removal of a stone from the common duct; to avoid parenchymatous hemorrhage from the liver, gall-bladder was not separated from same, but the attached part of its wall left behind. Wound perfectly dry at end of operation. In the course of the second day some slight bleeding began; 800 c.c. of blood taken from patient's husband, and serum obtained therefrom, injected in doses of 30 c.c. each. At first some improvement, but at end of fourth day renewed hemorrhage had so weakened the patient that a direct transfusion of blood from her sister was made; however, patient died soon after the termination of the transfusion.

While undoubtedly the serum injections will be found most effective when given before operation and resumed directly after operation, the following case (also here reported by the kind permission of Dr. Torek) proves that their postoperative use may also be of use in overcoming a parenchymatous hemorrhage setting in at a later date of the after-treatment.

E. K., aged twenty-five years; married; admitted to German Hospital December 29, 1910. Gallstone attacks six weeks ago; jaundice present for four weeks; stool clay-colored; prophylactic serum injections for four days, three times 30 c.c. on first, 30 c.c. each on the three following days. January 7, 1911, cholecystectomy; tamponade. Serum injections not continued. January 18, tampon removed; hemorrhage begins, capillary in character; dressings become gradually soaked; injections resumed, first day, 100 c.c.; second, 93 c.c.; then on an average of 45 to 50 c.c. per day; 413 c.c. in all during seven days. Hemorrhage stops definitely. January 23, hemoglobin 18 per cent.; red blood corpuscles 1,200,000. February 6, hemoglobin 54 per cent.; red blood corpuscles 3,800,000. Temporary duodenal fistula; final recovery.

Another favorable result of the method was observed by Dr. B. T. Tilton, of New York, who injected 90 c.c. (3 ounces) of the serum the day before operation, in a case of cholemia due to common duct stone. A very large stone was removed from

the common duct; there was practically no postoperative oozing; patient made a perfect recovery.[1]

Although not strictly belonging to the subject under consideration, I would here briefly add the history of two patients, which will prove the value of the method in

Hemophilia in the Adult.[2]

Case I.—Man, aged thirty-four years; right inguinal reducible hernia, congenital; retained testicle; left varicocele. Operation six years ago at another hospital; unsuccessful attempt at orchidopexy; six weeks in hospital; patient pronounced a bleeder and advised never again to submit to an operation. Of late, pain in retained testicle; impotency, due in part, it seems, to his brooding over malformation. Orchidopexy and Bassini's operation on right side advised and done December 1, 1910, plus operation for varicocele on left side; careful ligation of bleeding vessels; wounds closed; much pain soon after; following day, skin tender and ecchymosis in gluteal regions and up to prepuce; eighteen hours later, first change of dressing. Both wounds distended with coagulated blood; oozing of fresh blood; left inguinal canal filled; suggilation extends up to level of umbilicus and down to thighs; immediate withdrawal of blood from patient's relatives (two brothers and one sister) and serum injections begun six hours later (30 c.c. three times for four successive days). Oozing stops definitely; no rise of temperature; subcutaneous blood clots gradually discharged, without recurrence of hemorrhage.[3]

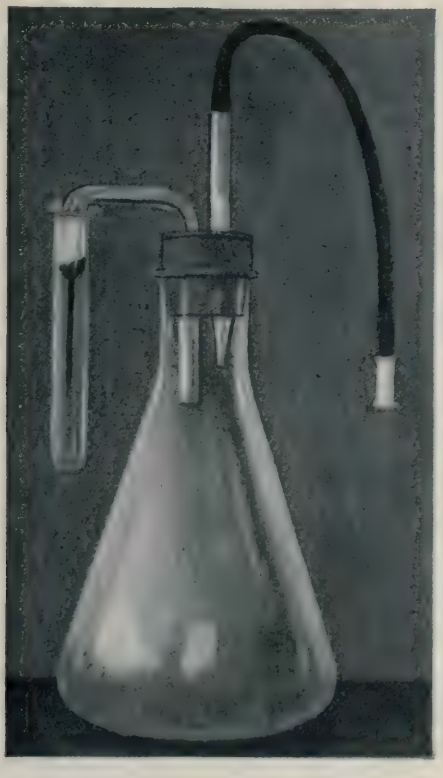
Case II.—Mrs. S. S., aged sixty-two years, married; several gynecological operations; always extraordinary hemorrhage; was called "bleeder." Myxosarcoma of right gluteal region; prophylactic and postoperative hypodermic injection of normal

[1] Medical Record, September 3, 1910.

[2] Welch believes that normal human serum will be an effective therapeutic agent also in cases of bacteremia.

[3] It is possible that prophylactic treatment with serum injections would have prevented the secondary oozing in this case.

blood serum derived from a healthy man secured by advertisement; 4 x 30 c.c. two days before, and two days after operation same amount; 480 c.c. (16 ounces) in all;[1] tumor, the size of a baby's head, removed with help of inverted anchor incision; bleeding during operation not severe; careful ligation; no secondary hemorrhage; speedy recovery.



Welch's apparatus for collecting the blood serum.

With reference to technique, I would refer to Dr. Welch's article, mentioned above. His apparatus for collecting the blood serum ought to be on hand in the laboratory of every hospital (see figure), as also a serologist or assistant who is trained

[1] It is important to remember that large quantities of the blood serum have never done harm; in fact, they have been more effective than smaller amounts.

in the puncture of veins and aspiration of blood. After collection of the blood the flask is placed obliquely in a round basin on gauze or cotton; four to six hours later the serum will have separated and be ready for injection. A 30 to 60 c.c. (1 to 2 ounces) glass syringe, with glass piston, should be on hand. The neck of the flask containing the blood clot, with serum above, remains plugged with sterile gauze; the neck of the bottle is always heated by an alcohol flame before the serum is withdrawn.

In conclusion I would say that, according to my belief, subcutaneous injections of normal blood serum mean a decided advance in our therapeutic possibilities to bring under control alterations in the blood, hitherto more or less beyond our reach. The method is simple and safe, and can be easily repeated as often as required.

It stands to reason that in exsanguinated and profoundly anemic patients direct transfusion will remain the operation of choice. But in cases of obstinate parenchymatous hemorrhage, as often seen after operation for chronic jaundice and in hemophiliacs, it seems probable that Welch's serum injections will represent a welcome substitute for the often cumbersome transfusion, which, besides, is not always void of danger to the patient.

Of course, in estimating the value of Dr. Welch's method, it must be borne in mind that only a certain percentage of patients afflicted with chronic jaundice are attacked by secondary hemorrhage.

Nevertheless, it must be conceded that, if further experience should confirm the observations made in the cases here reported, and show definitely that in the subcutaneous injection of normal human blood serum we have a reliable and safe means of combating this serious complication, surgery has again made an important step forward, thanks to the combined work of laboratory and hospital.

ACUTE INTESTINAL OBSTRUCTION DUE TO INTUSSUSCEPTION CAUSED BY A LIPOMA OF THE DESCENDING COLON; RESECTION OF THE COLON; RECOVERY.

By HENRY R. WHARTON, M.D.,
PHILADELPHIA.

Intussusception, comparatively with other intra-abdominal surgical conditions, is an accident which may be regarded as rare. Benign tumors of the intestine provocative of intussusception are rarer, and acute intestinal obstruction due to intussusception caused by a lipoma is one of the rarest conditions to confront the surgeon.

A thorough review of medical literature reveals but 19 cases of acute intestinal obstruction due to this cause. Of these cases, treated variously, there are recorded only five recoveries following laparotomy. In view, therefore, not only of the rarity of this condition, which attracts more interest from the pathologico-anatomical than from the clinical standpoint, but also because of the few recoveries that have occurred after intra-abdominal intervention, it may be justifiable to report two other cases successfully operated:

Case I.—Mrs. J. C., aged thirty-three years, a patient of Dr. J. R. Crawford, was admitted to the Presbyterian Hospital, in my service, on March 13, 1908, with the following history: The patient stated that on March 9 she suffered from cramp-like pain in the lower abdomen, for which she took castor oil. This was followed by a fecal evacuation, but an increase in the abdominal pain. On March 11 she passed a stool containing blood and mucus. Vomiting also occurred on this date.

Examination, upon admission, demonstrated no abdominal distention, but flabby abdominal walls. The pulse and temperature were normal. An indefinite tumor mass was palpable in the left iliac fossa. Slight tenderness and rigidity were palpable on the right side of the abdomen over the appendicular region. Rectal examination demonstrated no mass, but was followed by the discharge of a small quantity of bloody mucus. On March 14, as the case was thought to be one of intussusception, operation was advised and accepted.

Operation. An incision four inches in length was made through the left rectus muscle and peritoneum, exposing the descending colon, exhibiting a mass about three inches above the sigmoid flexure. Upon examination this mass proved to be an intussusception of the descending colon. The intussusception was reduced by gentle manipulation, whereupon it was discovered that there was present in the colon a firm mass, which by manipulation could not be displaced upward or downward to any marked extent. The colon was then incised over the mass and a purplish-colored tumor, two and one-half inches in length by one and one-half inches in diameter, was exposed, arising apparently from the mucous membrane of the wall of the colon. The tumor was attached to the wall of the bowel by a short, broad pedicle, having its origin from more than one-half of the circumference of the intestine. Owing to the extensive surface of attachment of the tumor, it was decided that resection of the bowel was necessary to secure its complete removal. Accordingly, about two inches of the colon, including the attachment of the tumor, were excised, and the divided ends of the gut were brought together and held in apposition by a Murphy button. A gauze drain was introduced to the site of anastomosis and the wound closed by tier sutures.

The patient did well after the operation. On the thirteenth day following operation an *x*-ray examination showed that the button had passed into the rectum, from which it was removed. The wound closed on the fifteenth day and the patient was discharged from the hospital on May 8. Her physician reports

that she has been in good condition since leaving the hospital, and is well at the present time.

Pathological Report. Specimen is an irregularly oval mass of tissue measuring approximately, $2\frac{1}{2}$ by $1\frac{1}{2}$ inches in its two diameters. The exterior of the tumor is covered by mucous membrane, which in places has undergone ulceration, most

FIG. 1

marked over its free end. A longitudinal section presents the oily surfaces of fatty tissue exhibiting a lobulated configuration. The consistency is that of ordinary compact adipose tissue. (See Figs. 1 and 2, demonstrating respectively the external and internal appearances of the tumor.)

Histologically, the appearance is represented by the microscopic drawing (Fig. 3). The mucosa, muscle, and a minute

portion of the adipose tissue is clearly depicted. Although no area of ulceration of the mucosa is shown in this field, two foci of extensive inflammatory cellular infiltration are conspicuous in the mucous membrane. The microscope definitely establishes the

FIG. 2

subserous nature of the tumor, inasmuch as it is separated from the mucosa by the intervening muscular coat of the intestine.

Diagnosis. Subserous lipoma.

CASE II.—Mr. J. D. W., aged thirty-five years, admitted to the Union Protestant Infirmary January 10, 1911.[1]

[1] This case was brought to my attention by Dr. John M. T. Finney, of Baltimore, after this report had been undertaken, who has kindly permitted me to incorporate it in this article.

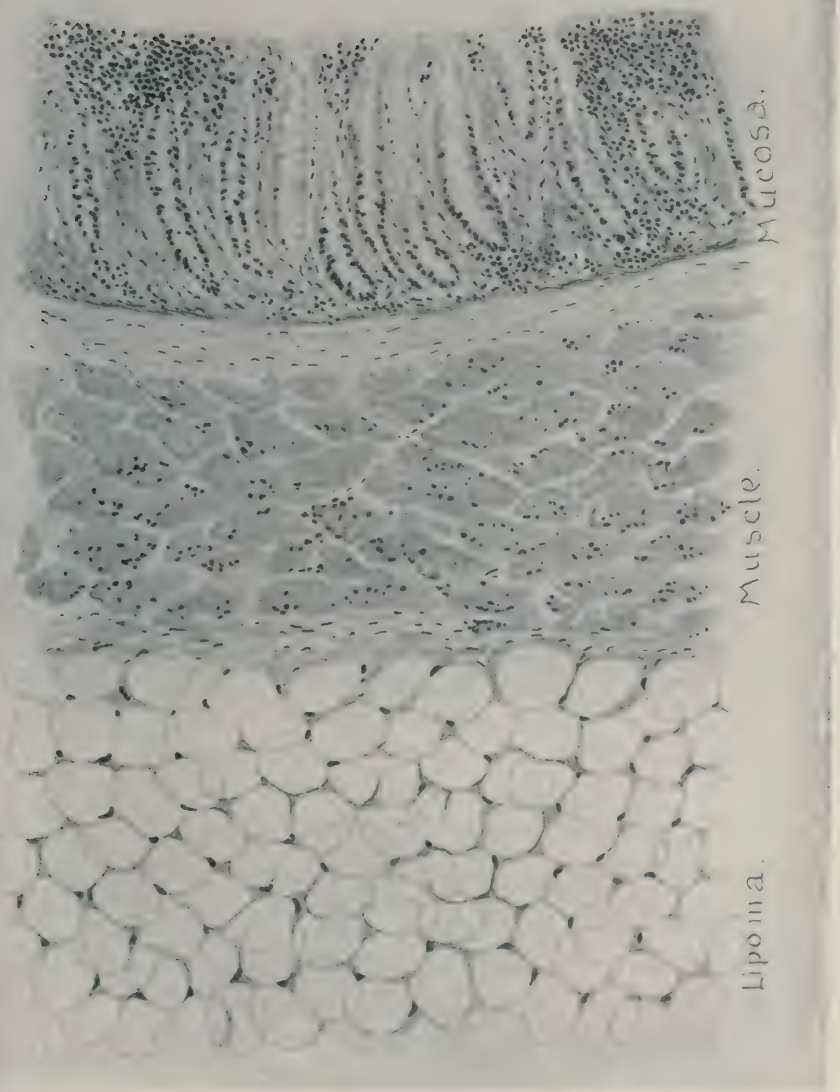


FIG. 3

Upon admission, patient gave an absolutely negative previous medical history. His attack began five weeks prior to admission, with the history of having been awakened at 5 A.M. by pain in the abdomen, followed by several blood-streaked stools during the next two hours. Throughout the day he had frequent attacks of pain along the left side of abdomen. The following day he could feel an indefinite mass on left side, which disappeared in a few days. One week later patient began to pass two to three tablespoonfuls of blood with each stool. The stools averaged two to three per day for about three days, with the assistance of hot enemata. Patient had a third attack a week later. Two weeks ago he was admitted to the Charlotte Hospital, and received treatment by enemata, which was followed in two or three days by the passage of yellow mucus. For the last three weeks he has had pain just above the rectum and in the back. Slight tenderness upon pressure over the left side of the abdomen. Abdominal palpation was difficult because of rigidity of the muscles. No mass was palpable. The finding of tubercle bacilli in the fecal discharges prompted the diagnosis of tuberculous ulceration of the colon.

Operation. Upon opening the abdomen a mass about the size of a lemon was found in the descending colon just below the splenic flexure. This mass first suggested an intussusception, as a portion of the wall of the colon was invaginated with the segment just below it. An attempt was made to relieve this invagination, but it was found impossible to do so. It was therefore decided to resect this portion of the colon. It was found necessary, in order to facilitate the subsequent anastomosis of the two portions of the bowel, to resect practically the whole of the descending colon, together with the splenic flexure, after which it was very easy to oppose the transverse colon and the sigmoid flexure. The intestine was divided with the actual cautery between two clamps and the divided ends invaginated into the lumen after the manner of the treatment of the stump of an appendix. A lateral anatomosis was then performed in the usual way.

The patient made a good recovery, with the exception of an infection in the lower angle of the abdominal wound, which necessitated the reopening of this angle and healing by granulation. He left the hospital on March 1, 1911, in excellent condition, with a healed wound.

Pathological Report. Examination of the specimen showed a lipoma of the size of an English walnut or larger, arising from the mesenteric border of the intestine. The lipoma was somewhat pedunculated, and had gradually encroached upon the lumen of the bowel, until finally it had almost occluded it, and in the effort of the intestine to pass on the obstruction, a partial intussusception had been brought about. The surface of the lipoma was gangrenous with some ulceration, which had evidently given rise to the bloody mucous stools prior to the operation. The microscopic examination of the tumor revealed nothing but fat and fibrous tissue.

The following cases of intussusception due to lipoma have been collected after a painstaking search through the literature. They number but 19, exclusive of the 2 included in this article, and in reviewing the individual cases, for the sake of brevity, attention has been directed merely to the notation of the reporter, with his reference, the age, sex, prior history of the patient, the character of the onset of the attack, condition of intestines, rectal and abdominal findings, operation, site and pathology of the tumor, and the result of the case.

1. Meckel (*Handbuch der Pathol. Anat.*, Leipzig, 1816) reports a case of his father's where a lipoma caused an intestinal invagination.

2. Virchow (*Die krankhafte Geschwülste*, 1863, Band i, p. 382) reports the case of Sangalli, where two submucous lipomata were found in the descending colon, one being the size of a hen's egg and pedunculated, and had produced invagination and finally prolapse.

3. Castelain (*Gaz. Hebd.*, 1870, No. 20) reports the case of a male, aged forty-three years, who previously was troubled with

habitual constipation. Attack began with loss of appetite, nausea and constipation, and rectal tenesmus. Presence of blood and mucus at anus was followed in the fourth week by discharge of large pedunculated tumor, which proved to be lipoma. Recovery.

4. Ninaus (*Verein d. Aerzt. in Steiermark*, 1871) cites the case of a male, aged thirty-two years, with previous history of intermittent attacks of pain for months. Present attack began with acute pain, vomiting for eight days, and constipation. On the eighth day blood was observed in the rectum. Was operated on the twenty-sixth day. A discharge of slough was followed by recovery. Pathologically the intestinal segment was found to have a lipomatous polyp. Obstructive symptoms recurred a year later, and he was never well afterward.

5. Albrecht (*Petersb. med. Wochenschrift*, 1880, No. 9) reports the case of a male, aged fifty-one years. Attack began with pain, followed by diarrhea. Mucus and blood were found by rectal examination. During the sixth week a pedunculated lipoma was discharged from large intestine.

6. Vois (*Norsk. Mag. f. Lagevidere*, 1881) reports the case of invagination of the lipoma into rectum. The tumor was resected and the intussusception reduced by water injection.

7. Marchand (*Le Progrès Méd.*, 1882, No. 11, p. 202) records the case of a female adult. Attack was recurrent after nine months. Patient had absolute constipation. Rectal examination demonstrated a tumor 8 cm. from anus. Operation consisted of sigmoidostomy. Patient died. Autopsy revealed a lipoma at apex of intussusception.

8. Brohl-Tuffier ("Invagination de S'iliaque dans le rectum. Lipom de l'intestin," *Le Progrès Méd.*, 1882) reports the case of a female, aged forty-three years, having the previous history of increasing constipation for nine months and pain for four months in left inguinal region. Rectal examination revealed a tumor. Laparotomy displayed an invagination of S. romanum into the rectum. The intussusception was irreducible, and an inguinal colostomy was performed. Patient died of peritonitis

on fifth day. Postmortem examination revealed an orange-sized, pear-shaped, pedunculated submucous lipoma located in the lower part of the S. romanum.

9. Clos (*Thèse*, Paris, 1883) reports the case of a female, aged forty-five years. Attack began very acutely with typical symptoms of ileus, and patient speedily died in spite of artificial anus. Autopsy revealed a lipoma, size of an orange, located in the rectum, producing an invagination of the bowel.

10. Brohl (*Dissert. Würz.*, 1886) cites the case of a female, aged forty years. Patient gave the history of abdominal pain of fifteen years' duration. For a year prior to onset she experienced a sense of something coming down. Examination of rectum demonstrated descent of invaginated lipoma, later confirmed by histological examination.

11. Treves (Leipzig, 1888) reports the case of a female, aged eighty-three years, who had previous history of indigestion and colicky pain. Diarrhea alternated with constipation, and finally a lipomatous polyp was discharged. Microscope confirmed diagnosis of lipoma.

12. Studsgaard (*Nord. med. Arkiv.*, 1894) reports the case of a female, aged forty-two years. Laparotomy displayed an irreducible intussusception of the jejunum, requiring resection. Patient died of peritonitis in five days. Pathological diagnosis: Polyp, lipoma.

13. Marchand (*Berlin. klin. Wochenschrift*, No. 6, p. 135. Aerzlich, Verein zu Marburg, Case 3, 1896) cites case of a male, aged twenty three-years, who gave the previous history of having fallen on side while dancing. Onset was marked by acute pain, vomiting, and symptoms of intestinal obstruction. An enterostomy was performed on the fifth day for supposed obstruction; ileocolic into descending colon; death. Pathological examination demonstrated a subserous lipoma of cecum.

14. Hiller (Bruns, *Beiträge zur klin. Chirurgie*, 1899, xxiv, p. 509) reports the case of a male, aged fifty-one years. The attack began with occasional pain and vomiting, constipation, rectal tenesmus, and moderate abdominal distention. At opera-

tion, attempt at reduction of ileac invagination produced a tear, necessitating resection and end-to-end anastomosis. Patient died. Pathological examination showed the intussusception to be due to a submucous lipoma.

15. Brunner (Bruns, *Beiträge zur klin. Chirurgie*, 1900, xxv, p. 344) reports the case of a male, aged fifty-one years. His attack consisted of pain of six days' duration, absolute constipation, rectal tenesmus, blood and mucus, abdominal distention and rigidity, and palpable tumor within sphincter ani. Operative procedures consisted of removal of tumor per anum, followed by laparotomy and colostomy, with subsequent closure of artificial anus. Patient recovered. Pathological diagnosis: Submucous lipoma.

16. Haasler (Langenbeck, *Arch. f. klin. Chirurgie*, 1902) reports the case of a male, aged twenty-five years. Attack was of one week in duration, beginning with sudden pain, vomiting, and diarrhea. Rectal examination revealed pus, and a tumor was palpable to the left of the umbilicus. Operation consisted of resection of transverse colon and removal of mass, size of three fists. Pathological examination demonstrated a submucous lipoma at apex of intussusception. Recovery.

17. Zum Busch (*Cent. f. Chir.*, 1903, p. 733) reports the very interesting and unique case of a male, aged twenty-one years, who for fourteen months had dull pain about umbilicus, with alternating constipation and diarrhea. The patient was an athlete, accustomed to holding several men upon his abdomen. The acute attack began with vomiting, associated with frequent fluid stools and great tenesmus. Tumor was demonstrable and rigidity was present in the lower right quadrant. Rectal examination revealed blood. Laparotomy displayed a gangrenous condition of the bowel, rendering reduction difficult and demanding resection, followed by side-to-side anastomosis. Intussusception proved to be ileocolic and contained a tumor. The tumor proved to be an inverted Meckel's diverticulum, with a subserous lipoma at apex. Recovery.

18. Ray (*Lancet*, 1905, i, 567) cites the case of a female, aged

thirty years, having had pain for six months in left iliac and lumbar regions, chiefly during and after defecation. For forty-eight hours previous to operation she had severe pain and vomiting. Enema caused tumor to protrude from anus. Operation consisted of reduction and removal of growth through enterotomy of sigmoid. Pathologically, a subserous lipoma was diagnosticated. Recovery.

19. Lorenz (*Jahr. d. zw. ch. klinik.*, Wiesbaden, 1906-07, 41 to 44) reports the case of a male, aged fifty-eight years, whose attack began gradually with symptoms of chronic intestinal stenosis. A sausage-shaped, transverse, alternately hard and soft tumor was palpable in abdomen. Laparotomy revealed an ileocecal invagination with tumor on ileocecal valve. The lower ileum, cecum, and ascending colon were resected. Pathological examination demonstrated lipoma. Recovery.

20. Wharton reports a case of intussusception due to lipoma and causing acute intestinal obstruction. (See above, Case I.)

21. Finney reports an almost identical case. (See above, Case II.)

Although intussusception is in the vast majority of cases an accident of childhood, indeed, not more than 10 to 30 per cent. of cases occurring in adults, it is not proposed to digress from the subject under consideration further than to note that Clubbe (*The Diagnosis and Treatment of Intussusception*, 1907), in his splendid monograph on this subject, reports a personal experience with 144 cases, only 14 of which were over one year of age. One hundred and twenty-four laparotomies were performed, with a mortality of 32.2 per cent. In no case was a tumor, much less a lipoma, the cause of the intestinal invagination. Indeed, the etiological influences of tumor in the production of intussusception seems to be restricted entirely to adult life. These tumors may be benign or malignant. Under the benign may be classified polyp, lipoma, adenoma, fibroma, myofibroma, myxoma, myxofibroma, papilloma, and cyst. The tumor is practically always affixed to the apex of the invagination. The malignant tumors are essentially degenerations of primarily benign neoplasms.

It can be no longer doubted that simple intussusception is almost always induced by irregular and increased peristaltic activity of the intestines. This explains why children, in whom peristalsis is most active, become the usual victims of this accident. On the other hand, not only for the child, but for the adult as well, there are certain anatomical factors, associated with or without trauma, which play an important role in the production of intestinal invagination. They are the difference in diameter of the ileum and cecum, prolapse of the mucosa of the ileum, abnormal mobility of the mesentery, benign and malignant tumors of the intestine, intra-intestinal foreign bodies, and finally certain para-intestinal appendages, as appendices and inverted Meckel's diverticula.

Of these causes producing acute intestinal obstruction due to intussusception we will consider only lipoma. A review of the 21 cases abstracted above reveals the fact that there are only 7 successful laparotomies, involving a resection or an enterotomy, of these the present report contributes 2. Although 12 recoveries are recorded, and the result not stated in 3, in a number of the cases it will be seen that either a spontaneous cure occurred by sloughing away of the intussusception, or an excision of the intussusception and tumor per rectum was performed. Six patients died. Below are tabulated the 7 successfully laparotomied cases of intussusception due to lipomata producing acute intestinal obstruction.

CASES OF INTUSSUSCEPTION DUE TO LIPOMATA SUCCESSFULLY OPERATED BY LAPAROTOMY IN ACUTE INTESTINAL OBSTRUCTION.

No.	Reporter and year.	Sex.	Age.	Prior history.	Onset.		Condition of intestines.	Rectal findings.			Abdominal findings.			Operation.	Site.	Pathology.	Result.
					Acute.	Chronic.		Tumor.	Blood.	Mucus.	Tumor.	Distention.	Rigidity.				
1	Brunner, 1900	M	51	Negative	+	—	Constipation	+	+	+	—	+	+	*a*, excision per anum *b*, laparotomy *c*, colostomy	Rectum	Submucous lipoma	Recovery
2	Hassler, 1902	M	25	Negative	+	—	Spurious diarrhea	—	—	+	+	+	—	Resection	Transverse colon	Submucous lipoma	Recovery
3	Zum Busch, 1903	M	21	Dull pain about umbilicus for 14 months	+	—	±	—	+	—	+	—	+	Resection	Ileocecal	Inverted Meckel's diverticulum with subserous lipoma at apex	Recovery
4	Ray, 1905	F	30	Pain on defecation for 6 months in left iliac and lumbar regions	+	—	Constipation	+	—	—	—	+	+	Colotomy	Sigmoid	Subserous lipoma	Recovery
5	Lorenz, 1906	M	58	Symptoms of chronic intestinal stenosis	—	+	?	—	?	?	+	—	—	Resection	Ileocecal	Lipoma	Recovery
6	Wharton, 1911	F	33	Negative	+	—	±	—	+	+	+	—	—	Resection	Descending colon	Subserous lipoma	Recovery
7	Finney, 1911	M	35	Negative	+	—	Spurious diarrhea	—	+	+	—	—	+	Resection	Descending colon	Lipoma	Recovery

It is noteworthy that the mortality is highest when the attack is very acute and the obstruction complete; also, that when the onset was not so sudden the lipoma is larger, but located in the colon having a large lumen. An analysis of the cases relative to the location of the lipomata demonstrates the following:

Cecum	1
Descending colon	3
Ileocolic	2
Ileum	1
Jejunum	1
Rectum	3
Sigmoid	4
Transverse colon	1
Not stated	5
	21

Obviously, we cannot agree with Eliot and Corscaden ("Intussusception, with Special Reference to Adults," *Annals of Surgery*, February, 1911) in the statement that "intussusception occurring in connection with benign growths in the large intestine are situated in either the sigmoid or rectum." These lipomata are usually single, but may be multiple, as in Sangalli's case. Histologically, they can be classified as subserous and submucous. The former arise from a hyperplasia of the epiploic appendices, which, by their growth may invaginate the bowel and then by traction provoke an intussusception. The latter are alleged to cause the largest lipomata occurring in the colon and rectum, and find their origin in the submucosa. Although in the majority of collected cases this differentiation is not noted, and of the cases where the variety is stated there are 5 submucous to 4 subserous, we believe that in the future with more complete and accurate histopathological examinations this order may be reversed.

The male sex has been slightly more frequently afflicted.

Aside from the fact that intussusception due to lipoma is a disease of adult life, age is no criterion, as the condition has been found at all ages from twenty-one to eighty-three, although usually prior to the fifth decade of life. There may or may not be a previous history of abdominal pain and intestinal stenosis.

The symptoms are, of course, those typical of acute intestinal obstruction when the attack makes its appearance, not infrequently, however, preceded by a period of intermittent symptoms of partial obstruction. Commonly, the diagnosis of intussusception can be made by the exclusion of other possible causes, the presence of a palpable mass in the abdomen or rectum, and rectal tenesmus, blood, and mucus. The cause of the intussusception, however, is only discovered at operation or by the pathologist. The prognosis is always grave. It may be summed up in three words, the *deeper the better*, that is, the mortality is much less if the invagination occurs in the colon than if it takes place in the small intestine, and less in the descending than in the ascending colon.

The treatment of intussusception due to lipoma is always operative. Although a small percentage of cases have been and will be cured by spontaneous discharge of the intussusception and lipoma, to expect such a sequence would be the height of folly. Too much emphasis cannot be placed upon the earliness of operation. Care must be observed in attempting to disinvaginate the bowel, nor must much time be devoted to such an attempt. The best course is to reduce as much of the intussusception as may be quickly and easily accomplished, followed by enterotomy and the excision of the lipoma or intussusception plus lipoma, or preferably resection of the entire intussusception, which must necessarily be the procedure if the tumor has undergone malignant degeneration or has a broad sessile attachment to the intestine, or the gut is found to be gangrenous. On the other hand, if the patient be an adult and his condition precarious, inguinal colostomy or ileocolostomy may be performed advantageously. The operation of artificial anus as a palliative procedure for this condition in an infant should never be practised, as they invariably succumb. The lesser of the two evils is always to resect, although the prospect is hopeless. Should the lipoma and intussusception present at the anus, resection or excision per rectum, followed immediately by laparotomy to secure the continuity of the colon, is the preferable course to pursue.

AN ANALYSIS OF RESULTS YEARS AFTER OPERATION IN 640 CASES OF APPENDECTOMY.

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In order to determine whether appendectomy has cured the patient having symptoms referable to the appendix, we have made an investigation into the condition of a large series of cases years following operation. The cases forming this series were operated upon at the Massachusetts General Hospital Clinic. The surgical staff of the Massachusetts General Hospital operated upon these cases. The conditions under which operations were done and the methods employed were fairly uniform. The returns have been received from 640 cases. These end-results represent the end-results from a large series of operated cases, more than 3000 appendectomies. The facts concerning these cases which have been very carefully analyzed are as follows: There were 640 cases of appendectomy in this series; 178, or 27.8 per cent., of these were female; 462, or 72.2 per cent., were male.

The *ages* at which appendicitis occurred in the 640 cases were:

Years.	Cases.	Per cent.
1 to 10	19	2.9
10 to 20	161	25.1
20 to 30	230	35.9
30 to 40	120	18.7
40 to 50	64	10.0
50 to 60	27	4.2
60 to 70	9	1.4
70 to 80	1	0.15
Age not given	9	1.4
	640	

The whole number of herniæ following appendectomy was 65, or 10 per cent.; 23 cases, or 35.4 per cent., were female, and 42, or 64.6 per cent., were male.

The whole number of drained cases was 309, or 48.2 per cent.; 52 cases, or 17 per cent., of the 309 drained cases had hernia in the cicatrix of operation; 16 cases were female and 36 cases were male.

The whole number of undrained cases was 331, or 51.8 per cent.; 13 cases, or 3.9 per cent., of the 331 undrained cases had hernia in cicatrix of operation; 7 cases were female and 6 cases were male.

Frequency of previous attacks in the 640 cases:

	Cases.	Per cent.
No previous attack	226	35.3
One previous attack	115	17.97
Two previous attacks	128	20.0
Three to five previous attacks	85	12.97
Five to ten previous attacks	26	4.1
Ten to nineteen previous attacks	2	0.31
Many, frequent, constant, etc.	58	9.0
	640	

Severity of attacks:

	Cases.	Per cent.
Moderate	290	45.3
Severe	349	54.6
Not mentioned	1	
	640	

The time elapsed after operation when the results were known.

The results were obtained in 1 case 6 months after operation.
The results were obtained in 45 cases 1 year after operation.
The results were obtained in 9 cases 2 years after operation.
The results were obtained in 2 cases 3 years after operation.
The results were obtained in 4 cases 4 years after operation.

The number of cases which reported from one to five years after operation was 61.

The results were obtained in 24 cases 5 years after operation.
The results were obtained in 88 cases 6 years after operation.
The results were obtained in 113 cases 7 years after operation.
The results were obtained in 70 cases 8 years after operation.
The results were obtained in 101 cases 9 years after operation.
The results were obtained in 29 cases 10 years after operation.
The results were obtained in 48 cases 11 years after operation.
The results were obtained in 35 cases 12 years after operation.
The results were obtained in 28 cases 13 years after operation.
The results were obtained in 24 cases 14 years after operation.

The number of cases which reported from five to fifteen years after operation were 560.

The results were obtained in 12 cases 15 years after operation.
The results were obtained in 2 cases 16 years after operation.
The results were obtained in 1 case 17 years after operation.
The results were obtained in 1 case 18 years after operation.
The results were obtained in 1 case 19 years after operation.
The results were obtained in 1 case 21 years after operation.
The results were obtained in 1 case a number of years after operation.

The number of cases which reported from fifteen to twenty-two years was 18.

Conditions reported as good, very good, excellent, well, perfectly well, 606 cases, or 94.6 per cent.

Of these 606 cases, 95 reported health better than before operation.

Condition reported as poor *after* operation, 26 cases, or 4.6 per cent.

In this series of cases reporting poor health after operation there was mentioned:

	Cases.
No cause in	8
Indigestion in	6
Troublesome hernia in scar in	2
Peritonitis following operation in	2
Diabetes following operation in	2
Phlebitis following operation in	1
Gallstones were diagnosticated in	1
A panhysterectomy was done at time of operation in	1
Patient died of cancer within a year in	1
Postoperative neurasthenia in	1
Sacro-iliac disease occurred in	1
	26

Condition reported as health poor before *and* after operation were 8 cases.

In these reports were mentioned 2 right inguinal herniæ, 1 double inguinal hernia, and 1 case with both inguinal rings enlarged and with impulse on cough.

There were 4 cases of phlebitis following operation.

There were 9 cases reported as "nervous" after operation.

It is difficult at times to determine from the study of the record of a case whether the patient had an acute appendicitis or whether it was an appendicitis of chronic type. The clinical symptomatology or clinical picture may be very moderate in intensity, and yet the findings may suggest an acute process in the appendix. And *vice versa*, few changes may be present in the appendix, either gross or microscopic, and yet the attack may be most severe and acute. It seems unwise to attempt upon a clinical basis a differentiation of the acute and the chronic cases in this series. So long as the clinical facts are stated, and so long as the pathological findings are stated, nothing is omitted whereby the division into acute and chronic might be made.

It is reasonable to suppose that the cases which were drained were acute cases. Upon this basis, 48.2 per cent. were acute cases, and 51.8 per cent. were chronic cases.

There are a few exceptions to this method of division. There doubtless were reasons for draining the abdominal wound other than an acute process in or about the appendix. Such cases were possibly as follows:

Case 198.—Bowel torn and repaired. Wound drained, though there was no pus mentioned.

Case 326.—Mass of adhesions. Two grape-seeds. Wound drained.

Case 634.—Tied down by adhesions. Wound drained. Had trouble with gallstones.

Cases like the three mentioned must be excepted from this classification. Otherwise the classification holds satisfactorily.

Pathological and Operation Reports.

	Cases.
Appendix normal	13
No report	23
Appendix enlarged	106
Appendix clubbed	7
Appendix gangrenous, perforated	167
Few adhesions	79
Delicate adhesions	20
Dense adhesions	167
Pus	204
Serum	81
Blood	12

Cases Reporting So-called "Subsequent Attacks."

Case 5.—Complains of 30 or more attacks accompanied by nausea and vomiting. Has ulcers in the scar. Previous history of scrofula. Health fair at present, six years after operation. Nervous and hysterical before operation.

Case 21.—Complains of one attack. Health good except for "heart trouble." Previous to operation attacks for eleven years.

Case 78.—Has occasional attacks. Health miserable. Previous neurasthenia.

Case 83.—Has had similar attacks of pain as before operation. Has not worked since, as does not feel equal to it. Appendix was normal. Condition before operation not mentioned.

Case 86.—Had right-sided pain after operation. Not well. Died in four years of unknown cause. Condition before operation not mentioned.

Case 119.—A few attacks, not severe, and located near scar. Has lost weight and is somewhat constipated. Appendix atrophied. General health fair previous to operation.

Case 133. Four attacks lasting about two days. Health fair. More constipation. Condition not mentioned before operation.

Case 140.—Several, lasting from a few hours to several days. Health good. Condition before operation not mentioned.

Case 164.—One attack seven years after operation. Health excellent. Bowels regular. Condition before operation not mentioned.

Case 177.—Once in a while. Has hernia in "that region." Condition before operation not mentioned.

Case 211.—Off and on for three years. Health good, bowels more regular. Condition before operation not mentioned.

Case 221.—Several with piercing pain. Health good. Condition before operation not mentioned.

Case 232.—"Quite often." Hernia size of grapefruit. Fair health. Malaria before operation.

Case 235.—One attack, cured by physic. Health improved. Condition before operation not mentioned.

Case 271.—Several attacks two years after operation. Has become neurasthenic since operation. Looks well. Condition before operation not mentioned.

Case 290.—One attack, lasted one-half hour. Excellent health. Condition before operation not mentioned.

Case 305.—Has attacks, but not so severe as before operation. Health not so good. Bowels alternate between constipation and diarrhea. Condition before operation not mentioned.

Case 310.—Two attacks. Pain for three to four weeks. Health good. Condition before operation not mentioned.

Case 311.—Attacks. Always discomfort. Good health. Inflammation of bowels every year for five years before operation.

Case 319.—Attacks at first. Good health. Condition before operation not mentioned.

Case 334.—Attacks. Health poor. Condition before operation not mentioned.

Case 350.—Several similar attacks at first. Health good. Condition before operation not mentioned.

Case 366.—Constant attacks rather higher up. Health good. Constant indigestion. Condition before operation not mentioned.

Case 445.—One attack two months after operation. Health good. Condition before operation not mentioned.

Case 462.—Five to six attacks nearly as bad as before. Health improved. Condition before operation not mentioned.

Case 463.—Two attacks six months after operation. Health improved. Condition before operation not mentioned.

Case 482.—One attack five years after operation. Health improved. Condition before operation not mentioned.

Case 500.—Two attacks. Health good. Condition before operation not mentioned.

Case 517.—Two or three short attacks. Health improved. Condition before operation not mentioned.

Case 520.—Attacks. Health excellent. Bowels always loose with attacks of diarrhea. Condition before operation not mentioned.

Case 536.—Attacks. Never got strength back. Condition before operation not mentioned.

Case 537.—"Yes, when constipated." Health good. Condition before operation not mentioned.

Case 551.—One, lasted several days. Health good. Digestion poor. Condition before operation not mentioned.

Case 563.—One attack. Health good. Dyspepsia before operation.

Case 573.—One attack at first. Health never very good. Condition before operation not mentioned.

Case 621.—Attacks. Health excellent. Condition before operation not mentioned.

Case 625.—One attack. Health poor. Operation for hernia in scar one year after appendectomy. Hysterical before operation.

The numbers attached to the above cases indicate the number in the series of the 640 cases.

The attacks subsequent to the operation in the above 38 cases were the layman's idea of "an attack of appendicitis." They were not confirmed by the statement of a physician.

It will be noted from the variety of the disturbances spoken of as "attacks" that several of the cases were not genuine recurrences of appendix trouble. It will also be noted that in a large proportion of the cases the general health was pretty good in this group of 38 cases.

It is wise, of course, to keep in mind the fact that there is a distinction between a chronic attack of appendicitis and an exacerbation of a grumbling and persistent disturbance associated with pain and discomfort in the right iliac region, which so

often disappears after an appendectomy, which very often is dependent upon purely mechanical conditions caused by previous inflammation of the appendix. These disturbances, too, are quite different from an acute attack of appendicitis of infectious origin.

These so-called "attacks" could not have been appendicitis in any form, as the appendix had been removed in all these cases. It is of interest that certain of these cases seemed to have disturbances like the disturbances existing before appendectomy.

From the analysis of these cases certain important facts appear.

The drained cases are more likely to have a hernia in the cicatrix following operation. The undrained cases are less likely to have a hernia in the cicatrix following operation.

The results were obtained in these cases from one to twenty-one years after operation, so that it is reasonable to regard these results as real end or ultimate results; 94.6 per cent. of the cases were in good health and were relieved by the operation; 4.6 per cent. had poor health after the operation. Analysis of the cases making up this percentage is given, showing that there was definite pathological reason for the persisting poor health.

It may be concluded in general that in this series of appendectomies the operation benefited the patient, that comparatively few unnecessary operations were done, and that there were no distressing sequelæ.

It has been impossible to determine, of course, with absolute accurracy the occasion for postoperative pain. There were 88 cases in which it was thought that the discomfort, which was of varying degrees of severity, might be occasioned by adhesions following operation. This group of 88 cases has been secured after a very careful study of the reports of these patients, the 88 cases being 13.7 per cent. of the 640 cases.

Certainly the statement sometimes made that appendectomy is associated with distressing sequelæ is unfounded in this series of cases. Likewise, the statement that appendectomy is often followed by no relief to symptoms is not borne out by these cases, 94 per cent. having been completely relieved.

THE ERROR OF OVERLOOKING URETERAL OR RENAL STONE UNDER THE DIAGNOSIS OF APPENDICITIS.

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The diagnosis of appendicitis, after the enormous experience of the last twenty-five years, admits of little if any improvement either in method or in results. Occasionally, nevertheless, I meet with considerable difficulty in recognizing appendicitis with accuracy, or differentiating it from other rare lesions that may closely resemble it. The more I see of this disease, the more I am impressed by my ignorance of it. I cannot help recalling the positive conclusions to which I came after my first 5 cases. Indeed, now that my cases have risen into the thousands, I find that facts of great importance, especially in connection with the diagnosis, are constantly coming out—facts that in the beginning were never even suspected. Moreover, judging by the postoperative and unbenefited cases that come to me with symptoms and complications which the operator had apparently never suspected or understood, I feel that there may be others besides myself who occasionally overlook the real cause of symptoms and complications. For example, I may mention a left-sided tuberculosis (so it was diagnosticated, operated upon, and abandoned in Manitoba) which proved to be a chronic appendicitis following an acute perforative localized peritonitis. The patient was cured by removal of a thickened, scarred, and cheesy appendix.

In another case—that of a young man—I found a much-diseased appendix causing symptoms and physical signs which

made a genito-urinary specialist fear tuberculosis of the bladder, and a medical internist fear cancer of the lower sigmoid; and yet the diagnostic skill of these men was of the highest and their experience of the broadest. I had the same fears, but felt a strong hope that the lesion was an unusual form of appendicitis. This proved to be the case, and removal of the appendix restored the patient to health. Not a few instances have come to my attention in which similar error has occurred, and I have no doubt that others have been able to make in my cases, abandoned as hopeless and inoperable, an occasional brilliant diagnosis of the real condition of the appendix, and to accomplish complete operative cure.

A very puzzling case was one in which, under the diagnosis of appendicitis (which was correct), operation had been undertaken and abandoned. The operator could not find the appendix. Some months later, as the symptoms continued, I undertook in a confident spirit the operation, only to find myself searching in vain for the appendix through the right half of the abdomen. As there was no cecum in the right iliac fossa, I carried my incision high enough to explore the region of the gall-bladder, duodenum, and right kidney; but no sign of cecum or appendix could there be found. My assistant finally observed that the sigmoid flexure started in the right iliac fossa—that, in fact, the viscera were transposed, and that the appendix was in the left iliac fossa, easily accessible through the unusually long incision that I had made.

I will not speak of cases of salpingitis, ovarian tumor with twisted pedicle, extra-uterine pregnancy, cancer of the ileo-cecal valve, tuberculosis of the cecum, psoas abscess, perforation of the stomach or duodenum, strictures of the duodenum or jejunum from unsuspected malignant disease, gallstone, and cholecystitis, as well as many other organic lesions that I have mistaken for appendicitis. There are many more of these that are not even suspected. My subject—stone impacted in the right ureter and simulating appendicitis so that the operator has been deceived—seems to me, from its frequency and from the ease

with which the truth may be demonstrated, worthy of special consideration.

The number of cases in which appendicitis has been mistaken for a urinary calculus, or a urinary calculus mistaken for appendicitis, is not large, including the cases operated upon and unoperated upon, in the diagnosis of which a successful differentiation was made before operation. I have collected them all for this paper; but I may not have recognized all there were. In several the surgeon who removed the appendix never knew that the symptoms were due to ureteral calculus, and in some of my own I was at first deceived. How many cases I have operated on by taking out the appendix, with recovery from the operation and synchronous subsidence of ureteral symptoms, I do not know. I dare say that there have been several, judging from the frequency of ureteral stones in my cases since I began systematic search for them. Judging from some of the cases, a stone impacted in the ureter may stay there indefinitely, without any symptoms whatever, after subsidence of those of the original attack. That I have had at least one case like this, I know; that there have been others, operated upon and unoperated upon, without knowledge of the true pathology, I am quite prepared to believe.

One object of this paper is to show how easily one may be deceived; another is to show how easily one may escape error.

I look upon the multiplication of appendectomies with complacency, and without any special objection beyond that of inadequate indications for even this, one of the safest of operations. Except in the highly imaginative and neurasthenic, I do not think unnecessary appendectomy is likely to do any harm in the hands of those well fitted to perform abdominal operations. The *furor operandi* a few years ago directed against the ovary has been transferred to the appendix. But in the effort to find and remedy the cause of abdominal pain, removal of an apparently normal appendix is attended with many beneficent results. I have no doubt whatever that many appendices apparently normal are really dangerous to health and life. How

many serious attacks of appendicitis and peritonitis have been prevented by the numerous appendectomies there is no means of telling. That pain, discomfort, and fever are permanently relieved I know. I am beginning to see the benefits of normal appendectomies performed in the course of other abdominal operations, for in several cases other causes for peritonitis have been recognized, in the known absence of an appendicular cause. Furthermore, in the case of several patients I have been obliged to operate for acute appendicitis because I had not removed the appendix when it could have been removed easily and safely during some previous abdominal operation for other lesions.

It is this widespread belief in the value of appendectomy that makes us perhaps careless in our indications, and especially that indication which rests upon an accurate diagnosis. If we say that in the hands of good surgeons removal of the appendix is likely to do the greatest amount of good at the least exposure of danger and suffering, I admit the truth of this statement, but only when, by the elimination of other causes of pain and discomfort, we are as sure as we can be that we are not mistaking for an appendicular cause some other and more serious disease.

I am about to consider the ureteral stone as a not infrequent "other cause," but there are, I am sure, many other lesions which are and will be overlooked unless we search diligently for them.

My most recent illustration of these remarks—not twenty-four hours before these words were written—is the case of a girl, aged three years, with menacing symptoms of intestinal obstruction. A year ago a surgeon, operating for abdominal symptoms diagnosticated by the highest authority as appendicitis with abscess, found a slightly affected appendix, without abscess, but with a chain of enlarged lymph glands from the ileocecal coil to the receptaculum chyli. I found general peritonitis with no cause other than a broken-down gland in the ileocecal coil. This case shows that symptoms of appendicitis may arise from inflamed lymph nodes, and that the previous

removal of a prolific cause of peritonitis simplifies much the diagnosis. Its chief application is toward a careful search for causes other than appendicitis before appendectomy is undertaken.

I wish here to record again my belief and practice in the utmost care in diagnoses upon which depend operations of even the slightest magnitude. Indeed, the safer the operation and the less sure its necessity the greater the pains to be taken. Abdominal and other operations are performed upon the diagnosis of others, sometimes even upon the patient's own. I have seen too many operations introduced with a remark like this: "The patient is said to have appendicitis. I have not examined her." True, in most instances the operation is necessary; but were all efforts made and precautions taken, there would be little occasion to write upon subjects like that of this paper.

A young woman, a stenographer, to whom an operation and its cost were of the utmost importance—much greater than they are in the case of the idle rich—came to me and said: "I am afraid I have appendicitis, and I wish to know. I consulted a surgeon, and said, 'I have pain in my right side and I am afraid I have appendicitis.' He reached over his desk as I sat opposite, touched my side, outside of my clothes, corsets and all, and replied: 'Yes, you have. I will operate in the morning.' " This patient was unwilling to be operated upon after such an examination, and came to me.

It took me a long time to make up my mind in this case, for I had suspicions that the pain might be from a ureteral stone, an ovary, constipation, colitis, movable kidney, or neurasthenia. But, in the end, I came to the same conclusion that the other man did after reaching over the table and touching the girl's dress. I removed an appendix that looked as most slightly offending appendices look. The patient was cured of her pain. Now, it is in these cases that the rarer causes of abdominal pain are overlooked. Discredit is brought upon surgery; and, worst of all, that discredit is deserved.

The surgeon in his practice is confronted by the greatest

possible variety of abdominal pain, especially in women. It seems to me safe to say that without pain of some sort, at some time, the diagnosis of chronic appendicitis is impossible. It is quite conceivable that an infection of the appendix, the result of an acute process, may exist, quiescent, without pain or even discomfort; but there must have been at some time pain of some kind. The tenderness without pain is much less indicative of an affection of the appendix than pain without tenderness. I often find a tender, appendix-like body slipping under the fingers in the left iliac fossa. Such an object in the right iliac fossa I should unhesitatingly call a tender appendix, and, with pain, deduce an appendicitis. In the left iliac fossa it is, of course, not the appendix. If anything more than the edge of the colon, muscle border, or tendon or nerve, it may mean a ureteral stone, and this suspicion should indicate an *x*-ray, when, if the tenderness were on the other side, the diagnosis of appendicitis would be reasonably clear. But even on the right side these symptoms should indicate an *x*-ray, with or without red blood cells in the urine. Without some attribute of pain, neither the appendix nor a calculus need receive serious consideration.

When there is real pain without constitutional signs, my suspicions are directed toward a possible urinary stone by paroxysms of more than usual violence, even when appendicular colic is strongly suspected; intermittence suggests other than an appendicular source of pain. A severity requiring opiates or anything more than external applications, without fever, distention, vomiting, or other signs of beginning peritonitis, suggests stone.

In many of the cases we have no opportunity of judging the pain, for we get only the patient's history of it. In a recent case there were violent recurring attacks so suggestive that I made the diagnosis by the history alone. Dr. Dodd found by *x*-ray "a stone in the ureter near the bladder."

The kind of pain in chronic appendicitis seems to me to differ from that pain so characteristic of renal colic. To weigh the significance of pain in renal colic we must go back to its begin-

ning, to the spasm of its first engagement in the ureter, for the pain of an old impacted stone may be of no moment at all. Not so the pain in the early days of impaction. When the stone is first impacted the pain is so great that words can hardly describe it. Nothing but morphine or general anesthesia can control it. A stone caught and held immovably in the ureter, indescribable as is at first the agony that it causes, after a few hours or days, like the stone hopelessly impacted in the common duct, no longer causes pain. There may be even no discomfort. The acute spasm, the unbearable agony, are gone; the muscular spasms no longer continue in their original violence.

But there is one physical sign that always arouses or confirms the suspicion of ureteral stone. Blood in the urine, if only microscopic, is a symptom which should always demand an *x*-ray examination, though I have it made if anything in the history, no matter how trivial, arouses the suspicion of stone.

The diagnosis of ureteral stone simulating appendicitis is exceedingly easy and positive. It is made so by the *x*-rays, without which it could never be made with certainty. True, by ureteral catheterization scratches upon a waxed ureteral bougie, as Kelly suggests, almost prove the presence of a stone. But with the *x*-rays much more information can be obtained, and without pain or danger. The diagnosis is easy once a stone is suggested or suspected. The stone is overlooked, not because the diagnosis is difficult, but because the presence of the stone is not even suspected.

We all know, but we do not always realize the fact, that we overlook pathological conditions easy of diagnosis because we do not happen to think of them. How many times, for example, have I been groping about for a diagnosis, as bewildered as one lost in a fog at sea, but at the first sign of a fog bell knowing his exact bearings, so in the bewilderments of diagnosis I have felt reassurance the minute the right but overlooked possibility has been suggested. One pounces upon the diagnosis—every symptom in the history and physical examination will fit into and prove that diagnosis.

This statement is particularly true of ureteral stone; the surgeon is so impressed by the truth that he wonders he did not think of it before. The previous history of renal pain or distress, the intermittent attacks, the gradual shift of situation, the direction of the pain, and last, but most important, blood, even if in microscopic quantities—such symptoms suggest calculus and the *x*-ray examination. Skilful examinations by experienced *x*-ray men, controlled by repetitions with a ureteral instrument *in situ*, demonstrate the truth as absolutely as it can be demonstrated in surgical diagnosis.

With such precautions, error in diagnosis, which some years ago seemed to be quite unavoidable at times, is practically beyond serious consideration.

It is not so very important to make out beyond a question the exact diagnosis in acute abdominal emergencies—at least, it is not absolutely essential, because, whatever the pathological lesion may be, the conditions are such that it is without doubt necessary to explore. Not that an accurate diagnosis will not be somewhat of an advantage as guiding the surgeon directly to his lesion; but in emergencies time is always of such great importance that to spend it in attempting the impossible, when a stroke of the knife will make the diagnosis sure, is the worst of folly.

And yet there have doubtless been many unnecessary, and perhaps fatal, explorations which a little more careful study of the cases might have prevented; appendectomies and other explorations in typhoid fever; search for acute lesions that did not exist—such, for example, as the search for the cause of intestinal obstruction in the obstipation and pain of lead colic; search for blood when there was no blood; operation for extrauterine pregnancy when the pregnancy was normal. Furthermore, there have been many prolonged searches into regions remote from the real cause of symptoms which an accurate diagnosis would have done away with. There were in reality no such lesions. There has been search throughout the left upper quadrant when the lesion was in the right lower; search for a

mechanical cause of intestinal obstruction when there was the *ileus paralyticus* of peritonitis; for duodenal ulcer in cancer of the jejunum; for gallstones in pancreatitis; for a host of possible lesions remote from a simple gangrenous appendicitis—in a word, search everywhere but in the right place.

Scattered through my records are cases illustrative of all these things. In explorations shown to be unnecessary—in spite of that fact—the results have been recovery from the exploration, and, in many cases—perhaps through the suggestive effect of the operation *per se*—the patient has been restored to health. When really serious lesions have been found, but only after prolonged search, that loss of time has always added to the danger and increased the mortality. In most emergencies, however desirable the exact diagnosis, there is not much time to study the exact pathology. The surgeon should, however, employ the brief time at his disposal to be as accurate as the case and his experience will permit. Errors—whether of diagnosis or of operation—will occur, notwithstanding his care. They will not necessarily result from his want of care.

The whole aspect of the question is changed in chronic conditions. Then there is time in abundance to study the patient from every point of view. If diagnosis is humanly possible, then the diagnosis ought to be made, or, if not made, the reason why it is not made should be shown. I, for one, am tired of seeing abdomens opened for one thing when something else is found; and yet no one knows better than I do the limitations of human skill in diagnosis. As I write these words, at the Vincent Hospital my assistants are putting to bed a woman in whose case I was sure, both before and after anesthesia, of the diagnosis of uterine fibroid, and from whom I have just taken a tense, adherent, right-sided ovarian tumor. I claim for myself at least an ordinary skill in the interpretation of abdominal symptoms and in the digital examination. But, as I have said in other papers, there are certain differentiations in abdominal surgery that cannot be made with certainty, and that between the fibroid and certain other pelvic tumors is one of them.

We know it and admit it. Therefore, when an error like this is made we have discounted the limitations. In all errors the sting lies in carelessness, heedlessness, ignorance—in failure even to suspect the truth.

I am quite convinced that too little attention is paid to the diagnosis of chronic appendicitis. So long as there is pain or discomfort anywhere near the appendix, chronic organic disease is diagnosticated and the appendix is removed. I am not opposed to the removal of the appendix when it is diseased; I even favor its removal when apparently normal if it is easily accessible during other abdominal operations, for I believe that it is a threat to every life, no matter how innocent it looks.

When, however, it is proposed to open the abdomen for the special purpose of seeking and removing the appendix, that is an entirely different matter. Then it is necessary for the surgeon to be as sure as possible that he is on the right track; that it is, indeed, the appendix that is giving trouble, and not some other organ. The exploration is therefore not to be undertaken until all methods of diagnosis are exhausted.

It is here, I believe, that criticism of modern methods is indicated—I mean the too hasty conclusion that it is always the appendix that is at fault—criticism of the inadequate history, the superficial examination, the unfulfilled indications for operation.

In my opinion the less clearly necessary the operation the more clearly necessary the careful study of the history, physical examination, and contraindications; for the less justifiable the operation, the greater the disaster in case of failure. The greater the haste, the more bitter the repentance. The more neglected the contraindications, the harder to bear the failure.

I am not addressing the occasional operator so much as the expert in abdominal surgery and diagnosis. I have said elsewhere, perhaps too much, about the wrong done humanity and the science and art of surgery by those who undertake abdominal surgery without adequate preparation for its great difficulties and responsibilities. I do not expect such operators to avoid

even the most glaring mistakes, the most disastrous blunders, for they are not qualified either by education or by experience to avoid them.

My first experience of ureteral stone simulating appendicitis occurred some years ago in the practice of a colleague who asked me to see a patient in the next room upon whom he was operating, and in whom, instead of a chronic appendicitis, he had found a stone impacted in the ureter just above the sacro-iliac synchondrosis. I had never met with this lesion in suspected appendicitis, but soon after a similar experience in my own practice emphasized its possibility. I have been on the lookout for this source of error in chronic appendicitis, and have found in my records two dozen cases in which the diagnosis of stone in the ureter was made, but in which there was strong doubt as to that diagnosis until it was confirmed either by the *x*-rays or by operation. In the early cases the diagnosis of stone was strongly suspected, but no stones were found, as no operation was deemed necessary under the diagnosis of acute appendicitis. The patients recovered and were lost sight of. In all the later cases the suspicion of stone led, through *x*-ray investigation by an expert, to a demonstration which in most instances operation confirmed.

As my records approach the year 1911, the cases under consideration increase. Of the 22 (and I have no doubt that several cases have escaped my search), 5 have been operated on after correct diagnosis in 1911. The question of ureteral stone has come up in several other cases of suspected appendicitis, but that possibility has been eliminated by the *x*-rays. The diagnosis of ureteral stone seems, therefore, of considerable practical importance.

The occurrence of ureteral stone, though not common at the present time, is very much more common than it used to be, in my experience—it is common enough, now that my attention has been directed to the possibility of error, to make me think that in the past I may have overlooked not a few times this cause of abdominal pain, and have removed the appendix with-

out even suspecting the real cause. What became of these cases I do not know; it does not seem likely that all these appendectomies failed to relieve recurring pain without that fact in some way coming to me. It is not because I have written upon the subject that physicians are now sending me cases, for I have published nothing upon it. The reason why I have found so many cases is that I have looked for them, and no impacted ureteral calculi have, I believe, escaped my notice, and not because none came under my eye. I remember some years ago, before the *x*-rays were much used, and sometime before they were discovered, that I was called to cases of supposed appendicitis which I believed to be cases of renal stone, and upon which I did not operate. One or two patients with pain in the right abdomen under the scar of an appendectomy suggested a ureteral stone. These cases I have not included in this paper, for the diagnosis was not proved. From all my available cases in which the diagnosis is unquestioned, I select a few for illustration.

The first case, briefly abstracted, is that of F. W. A., a physician very familiar with appendicitis, who, with the physician attending him, made a diagnosis of acute appendicitis—a diagnosis that was confirmed by Fitz and myself. This patient I saw on Thursday, February 13, 1908. The first symptom was on Monday, and resembled so much a colic that the patient had had fifteen years before that he supposed it came from the same transitory cause. The pain stayed in the same place all Monday night. It was moderately severe. Morphine hypodermically relieved the pain. The bowels were constipated, and all Tuesday was spent in trying to move them. A profuse movement resulted Tuesday night. Pain became localized in the right groin Tuesday. There were two tender places low down in the right iliac fossa. Both testicles were drawn up. Catheterization was necessary. The pain became agonizing, and morphine had no effect upon it; ether alone controlled it. At the attack twenty years before there was no suspicion of a renal cause. There were two or three attacks of colic in the right side of the abdomen. The attacks came on with vomiting, and would leave for a day

or two a soreness in the right side. With the vomiting there would be a sharp pain, so intense as to make the patient faint. Since then there have been no attacks of colic.

There were signs of local peritonitis at the pelvic brim, perceptible by external and by rectal examination. The temperature was not over 100°. The diagnosis was acute appendicitis of moderate severity, with local peritonitis. The patient decided to await developments, and continued in about the same condition. On February 25 the local signs were much less, and the patient very comfortable. The temperature dropped to 99°.

In this case we felt sure of an appendicular origin, but there was a suggestion of renal colic in the history, which, in spite of the local signs in the right iliac fossa, led to an *x*-ray as soon as the patient could leave his bed. A shadow about the size of an almond was found at the level of the sacro-iliac synchondrosis. The advisability of searching for the stone, after proving the diagnosis by ureteral catheterization, was considered, but the patient, wisely, as the event proved, decided to await developments. His view of the case was as follows: Three years later, in August, 1911, he said: "I am practically free from disturbances of any kind. An occasional grumble in the abdomen is almost always proved to be intestinal in origin. There is no tenderness over the site of the stone; absolutely no bladder or urinary symptoms of any kind. Micturition is normal in quantity and frequency, and the urine is negative to examination. I weigh 205 pounds; rode in the automobile last year 13,500 miles, over all sorts of roads, with no disturbance or trouble. The last radiograph was taken over a year ago. At that time there was practically no change in the position or size of the calculus. As I look back it is my belief that this calculus has existed in its present location for over twenty years."

This case is used to illustrate the error of diagnosis rather than the treatment of ureteral stone. It is interesting to see that the stone remained thus impacted without causing disability of any kind. One cannot hope, however, often to see so fortunate an ending.

A somewhat similar case is that of Mrs. S., aged forty-five years, who was taken suddenly, on Saturday, with pain in the abdomen, followed by distention. There had been constipation for four days. With the pain and distention there was vomiting. On Sunday the pulse and temperature were up a little. On Monday morning the temperature was 102°; at night, 103°. At no time was there any rigidity in the right side. A mass could be felt in the right lower quadrant; it could be outlined very accurately by bimanual examination. In this case the diagnosis lay between appendicitis with abscess and pyosalpinx. There had never been any abdominal symptoms before. There was no loss of weight. In the diagnosis appendicitis, salpingitis, inflamed ovarian cyst, cyst with twisted pedicle, extra-uterine pregnancy, and some complication of a fibroid were considered. Operation showed a localized peritonitis with abscess at the brim of the pelvis and extending to the uterus and bladder on the right side. The patient made a good recovery. After the operation a sinus persisted. Some two or three months later with a probe I felt a very hard, gritty stone. This I removed with difficulty. The stone looked very much like a ureteral stone. I went over the history of this patient again with the greatest care to see if any signs of an impacted stone could be found. I never was able to determine positively whether this stone was of intestinal or of urinary origin. I always felt that it was of renal origin. It was arranged in concentric layers. It seemed to me that this stone had been impacted in the ureter and that all the symptoms and the abscess were the result of it. I never had any positive proof of its origin. The patient would never submit to an *x*-ray examination. There were no signs in the urine.

This case is of importance in connection with my subject because of the difficulty of telling whether the stone found in the abscess, supposed to be appendicular, was of renal or of intestinal origin. One must not jump to the conclusion, when a stone of this kind is found, that it has escaped from the ureter. It would have made the course of procedure of extreme doubt

had I found the stone at the time of the operation. Unfortunately this patient, an ignorant and timid woman, would not, as I say, consent to an examination which would have proved the diagnosis.

In the case of Miss S., on the other hand, the proof of the renal origin was clear. This patient, aged twenty-five years, had had a severe attack of pain in the right side for which the appendix had been removed. On her way to Boston she was taken with severe pain in the abdomen and went to the Springfield Hospital, where I found her suffering with right-sided pain. She had a temperature of 101° and a pulse of 120. Following this severe attack of pain the *x*-rays showed a single small stone in the ureter just above the pelvic brim. I explored the ureter at the Springfield Hospital in view of the findings of the *x*-rays. Instead of finding a stone in the ureter, I found a stricture where the stone may have been, but there was no stone. The kidney felt abnormal. I performed a ureteroplastic operation. The patient did well after this operation, but there was leakage of urine. At the time of the operation neither the patient nor the attending physician was prepared for so severe an operation as nephrectomy. Later, the patient came to the Corey Hill Hospital, where careful study with the *x*-rays showed stones in the right kidney. A study of the urine showed also suppuration on that side. Cystoscopy and ureteroscopy by Dr. Chute showed no urine coming through the right ureter. I therefore removed the right kidney. The patient made a good recovery and remains well. Dr. Whitney reported, "Diffuse focal suppurative nephritis."

This case illustrates the error in diagnosis better than any other at my disposal. While it is possible that the appendix may have been diseased and may have required removal, in my opinion the ureteral stone was the cause of the original pain and the appendectomy had no effect whatever. In all the cases of renal and ureteral stone that I have had, the possibility of appendicitis has usually been considered, especially if the urinary symptoms were conspicuous. I have taken special pains to inquire in all cases of renal calculus whether at any time the

diagnosis of appendicitis has been made. In many it has been made; in a few the appendix has been removed; and in practically all appendicitis has been considered only to be eliminated.

In a recent case, that of a man, aged forty-three years, the patient had always felt pain in front and back on the right side in the region of the appendix. There had been no urinary symptoms when the patient first consulted me. The attending physician and I had to consider the possibility of appendicitis before considering seriously stone, but the man was sent to Dr. Dodd, who immediately reported a large stone in the right kidney. In this case and in all cases of this kind without the *x*-rays one might easily be led to operate unnecessarily upon the appendix, overlooking entirely the possibility of a ureteral or a renal calculus.

Another case in which the possibility of an appendicular origin of right-sided pain was considered, but in which early resort to the *x*-rays, suggested by blood and pus in the urine, made the truth clear, was that of a man, aged thirty-eight years, who for three years had had right-sided abdominal pain. *X*-ray examination showed a stone which was passed spontaneously until it got impacted near the end of the urethra, whence it was easily removed. Later, pain in the right iliac fossa suggested either appendicitis or a second calculus. *X*-rays showed a stone a little beyond the pelvic brim. This also was removed.

A similar case was that of a woman, aged twenty-seven years, who in April, during catamenia, was seized with severe pain in the region of the appendix. In May, during catamenia, she again had severe pain in the region of the ovary and appendix which lasted several days. There was no blood in the urine. In July she had severe pain, with marked tenderness in the appendix region. There was, however, no rigidity or retraction of the abdomen. The pain lasted for four days and gradually subsided. It was so severe that renal stone was suspected, in spite of the pain in the region of the appendix and the marked tenderness over the appendix. The urine was carefully watched, and finally a little pus and blood were found in it. The *x*-rays

taken in July showed a calculus in the lower portion of the right ureter. This was removed successfully.

One must not forget that the appendix and stone may be coincident. I have two illustrations of this. In the first case, that of Mrs. S., there was, in 1898, a distinct history of renal stone—unmistakable and confirmed by the passage of a stone from the bladder. In July, 1903, there were such unmistakable signs of chronic appendicitis that I removed the appendix. In August, 1903, the patient was taken with an acute cholecystitis while on a vacation in the woods. Dr. Cousins, of Portland, drained the gall-bladder, but a sinus persisted. I finally removed the gall-bladder, with the cystic duct, which contained an impacted stone.

A case somewhat like this one was that of Mr. W., of Leominster. There were symptoms of chronic appendicitis; something in the history suggested a urinary calculus. *X*-rays by Dr. Dodd showed a stone in the right ureter not far from the bladder. I first removed this stone, which proved to be a phlebolith. The appendix was enlarged and thickened, and contained two or three firm concretions. Following the ureter back to the kidney, I found several calculi in the renal pelvis. While working at the kidney I could not help noticing that the gall-bladder was full of gallstones. The patient made a prompt recovery after removal of phlebolith, appendix, renal stones, and biliary calculi.

In these two cases, had there been no urinary calculi found, there was abundant evidence of a chronic appendicitis. Nothing called attention to the gall-bladder, however, and the stones at the time of the operation upon the appendix had not caused any symptoms whatever.

The cases which emphasized the error of diagnosis were those in which, after the removal of the appendix, symptoms of pain continued just the same. An appendix scar under which there is pain and tenderness has ever since these early cases suggested at once a ureteral cause. *X*-rays have shown that cause to be, in fact, present.

A final case illustrates why I now use the *x*-rays when I have made the diagnosis of appendicitis, but when there is some doubt in my mind. The condition found at the operation tends to show why this case had a kind of pain that an impacted stone might cause.

A girl, aged nineteen years, a stenographer, for a year has had recurring attacks of severe pain in the right iliac fossa, radiating in various directions. The pain lasted one or two hours, and was followed by tenderness. It was described as unendurable and paroxysmal. With each attack the patient had to give up work for two or three days.

Something in the case suggested the remote possibility of a stone, and I was unwilling to operate without an *x*-ray. The urine was normal in color, acid, and had a specific gravity of 1008. It contained no albumin and no sugar. The *x*-rays showed no stone, and with that assurance I removed the appendix, which was a long one. From the cecum to its tip it was a sharp V in shape. Beyond the angle the lumen was distended with feces; on the proximal side it was empty. This case seems to me to show well the reason why some appendices cause pain suggestive of an impacted stone.

The universal resort to the *x*-rays in abdominal diagnosis would be, I think, foolish. In the great majority of abdominal lesions the diagnosis is practically without reasonable chance of error, or, at least, of any error in which the *x*-rays would be of practical use. In the disease that I have been considering, however, habitual use of the method would obviate such mistakes as those that I have described. In my own practice I lean toward that side in which the *x*-rays are likely to prove superfluous, but in which the overlooking of a stone may mean disaster, rather than toward the side in which the chances of stone are, from the history and physical examination, so much in favor of stone that there is little possibility of error. I would make the *x*-rays more and more widely used; more and more a method of precision, especially when there is the least doubt. Not that I would abandon for a moment the *x*-rays to confirm beyond a

doubt a positive diagnosis; but I would extend their use to the much more frequent case in which the possibility of stone is suggested, if even remotely. Still further, I would use the *x*-rays in every abdominal case in which information of value is possible.

On the other hand, we must remember the sources of *x*-ray error, for even the most expert may make mistakes. I have been led into extensive and bloody search for ureteral stones that did not exist, as in the operation for phleboliths mistaken for ureteral stone; and yet this error may be avoided by the *x*-ray of a ureteral catheter in connection with this stone.

Such experiences suggest, of course, in the use of the *x*-rays, the highest experts who know not only the possible errors of conclusion, but how to overcome and neutralize these errors. It is by developing the *x*-ray methods in ureteral and genito-urinary surgery and in gastro-intestinal diseases that we shall find the greatest assistance in avoiding errors in diagnosis.

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